PROCEEDINGS

SECOND CONVENTION.

This Society is not responsible, as a body, for the statements and opinions advanced in its publications.

ANNUAL PRESIDENTIAL ADDRESS

BY RICHARD L. HUMPHREY.*

It is my pleasure to address you as President of the Association which was launched so auspiciously at that memorable convention in Indianapolis barely one year ago. It would appear particularly fitting on the first anniversary of this Association that such an address should dwell on the development in the uses of cement.

It is an old but trite saying that "there is nothing new under the sun," and I am taking this opportunity not for the purpose of relating anything new, but merely to refresh your memory on the facts concerning the increasing uses of cement.

The very full programme which has been arranged gives promise of so much interesting information that I shall endeavor to make these remarks as brief as possible.

The use of cement is very old. That the ancient Phoenicians and Egyptians understood the use of mortar is attested by the ruins of their massive masonry structures,—the joints of which contain hardened mortar.

It is stated by some writers that there is evidence of the use of mortar as far back as 4350 B. C. That the Romans made use of mortar at an early date is shown by the writings of Vitruvius, but, we also learn from Pliny that these mortars were bad,—for he tells us that,—"the cause which makes so many houses fall in Rome resides in the bad quality of the cement."

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From the downfall of the Roman Empire to the beginning of the 18th Century the manufacture of cement seems to have been discontinued. Such cement, mortars and concretes as survived the ravages of the elements had become so hard that Roman cement acquired a reputation for quality which led the earlier experimenters of the 18th Century to seek to recover this lost Roman art.

You are doubtless familiar with the impetus the use of cement received through the experiments of John Smeaton in 1756, by the patent issued to Parker for the manufacturing of Roman cement in 1796, and by the experiments of Vicat and Collet-Descotils.

Portland Cement proper, however, did not receive its birth until 1824, when John Aspdin received his patent for manufacturing Portland Cement, which he so named from its fancied resemblance to the building stone obtained from the Isle of Portland off the coast of England.

From this date to 1850 very little progress was made in England. In other parts of Europe the development from 1855 was steady and continuous.

Natural cement was first manufactured in this country by Canvas White in 1818 and reached its maximum development in 1899.

It was not until 1872 that American Portland Cement was manufactured by David O. Saylor, in Pennsylvania, in an experimental way. Three years later he was able to manufacture it successfully, and our first Portlant Cement was exhibited at the Centennial Exposition in 1876.

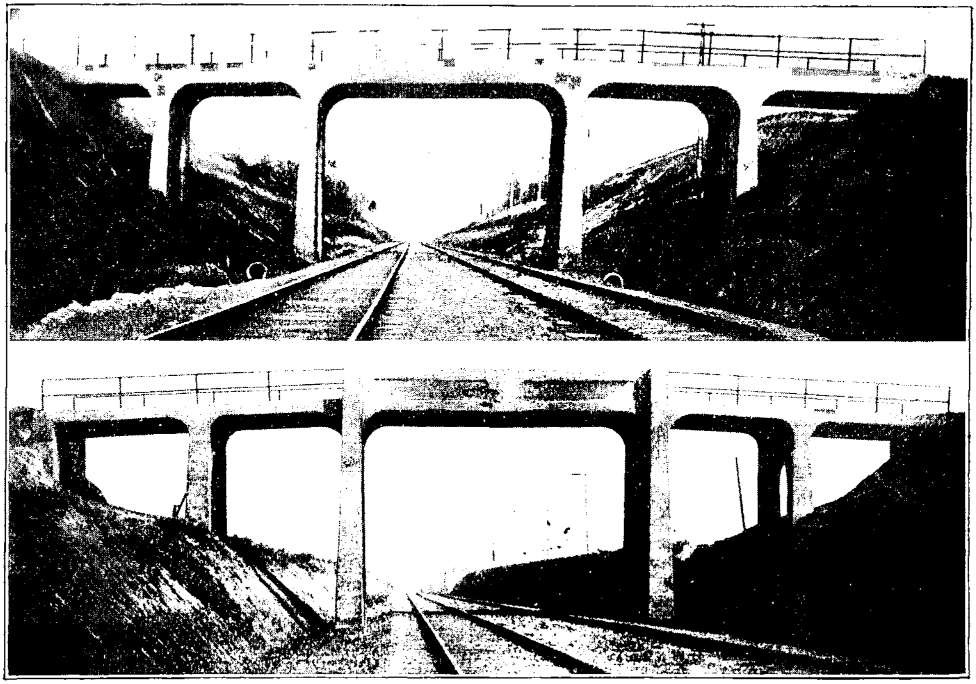
The slow development of this industry was due largely to strong prejudice against the American Portland Cement.

The successful introduction of the rotary kiln in 1889-1890 marks the beginning of the rapid and remarkable development both in the production and consumption of American Portland Cement. This is very clearly shown diagrammatically: the contrast between the capacity of the first cement plant in this country and the modern Portland Cement plants having capacities of from 2,000 to 10,000 barrels per diem, is just as great as the contrast between yearly production of 335,000 barrels in 1890 to the nearly 27,000,000 barrels produced in 1905. And this development is now not confined to one or

W. E. WARD HOUSE, CONCRETE SKELETON. BUILT 1875. NEW YORK.

two points, but is spreading over the entire country.

While it is true that the uses of cement in mortars for binding together masses of masonry or in concrete, is very old,—its use in the construction of arches, beams, columns and other structural parts is quite recent, and the remarkable development in the diverse uses to which it is put is all within



REINFORCED CONCRETE HIGHWAY BRIDGES OVER BIG FOUR RAILROAD.

the recollection of the present generation. These uses may be grouped as follows:

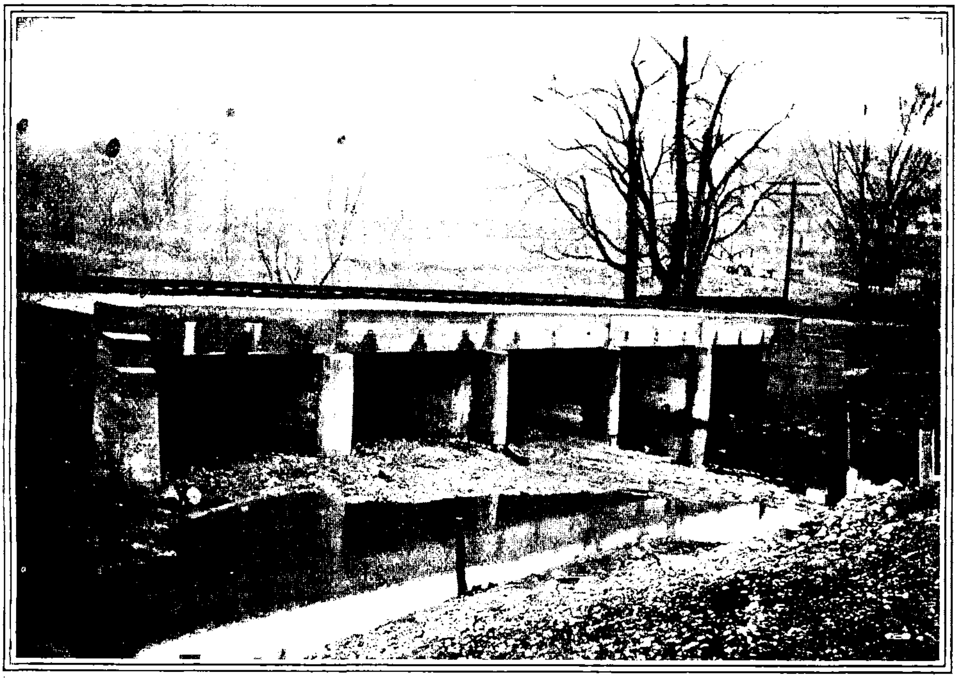
(1) In mortars, binding together large masses of stone or brick, etc., or for casting various forms,—e. g. artificial stone, hollow block, brick, etc.

(2) As concrete in mass or under conditions where it is only subjected to compressive stresses; and

(3) As reinforced concrete where it is subjected to both tensile and compressive stresses.

For the first part of group 1, it will be sufficient to observe that cement mortar is rapidly replacing lime and natural cement mortar.

It is worthy of record that on November 17th, 1850, Jos. Gibbs obtained a British patent for casting solid walls of concrete in wooden forms, while on March 6th, 1866, C. S. Hutchinson obtained a United States patent for hollow block



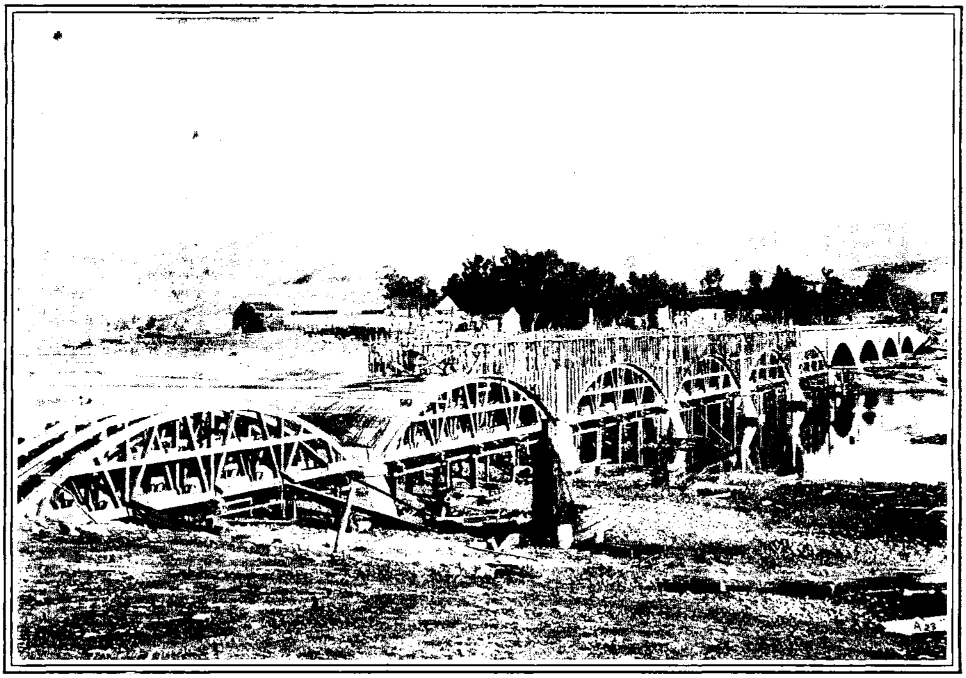
REINFORCED CONCRETE TRESTLE ON LINE BURLINGTON RAILROAD.

and brick walls making continuous vertical air spaces, and on April 14th, 1874, T. B. Rhodes also obtained a United States patent for hollow block and shingles. Patents were granted to C. W. Stevens for the manufacture of artificial stone in 1897, and to J. C. McClenahan in 1902.

The manufacture of artificial stone is now making progress and is successfully competing with cut stone work of ornamental character both in price and quality.

In the manufacture of hollow block there has been very unusual development. This class of building material has come to stay and it will only be a question of time when matters will so adjust themselves that first-class material will be uniformly produced and it will form a very desirable substitute for brick and stone, and in cheapness will eventually compete with wood.

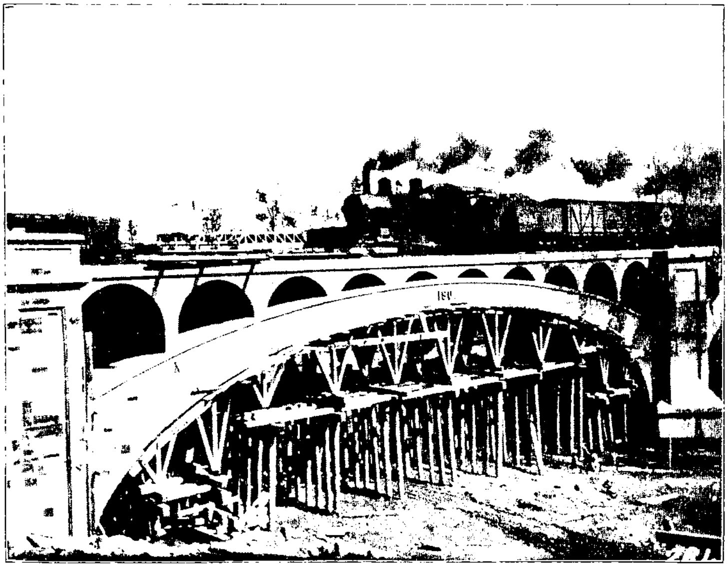
The use of cement has been quite general for many years



REINFORCED CONCRETE BRIDGE, POLLASKY, CAL.

for sidewalk work, and pavements of this character are by all odds the best attainable. As concrete, however, is deficient in edge strength, it has been found necessary to apply steel protection to the edges and there are patented excellent types of steel bound curbs on the market. The use of concrete for piers, abutments and arch bridges without steel reinforcement is too general to need comment. Additional information, however, is greatly needed as to the proper means for providing for the expansion and contraction of concrete in large masses. The first concrete arch bridge was built in this country in 1870 in Prospect Park, Brooklyn, and to the Erie Railroad is given the credit of having lined the first tunnel with concrete, namely that at Bergen, N. J. in 1874.

A notable development in the use of concrete for bridges is illustrated in the construction of the bridge over Rock Creek in Washington. The voussoirs for the arches of this bridge are molded separately, are then air-hammered dressed



REINFORCED CONCRETE RAILROAD BRIDGE, ILLINOIS R. R. BRIDGE OVER BIG MUDDY RIVER.

and then hoisted into position; these blocks being handled similar to stone, holes being cut for the dogs. The spaces between these rings and the spandrel walls are cast in place with concrete. No sand is used in the concrete for the arch ring, crushed rock screenings being substituted and the bluish color of the rock produces a marked contrast to the color of the concrete used in the spandrel walls in which a yellowish sand is used.

Concrete sewers, retaining walls, and harbor bulkheads of plain concrete are also so extensively used that they are no longer a matter of special interest. Reinforced concrete, however, is of more recent development. The use of reinforced concrete was probably known prior to 1855, for at the Paris Exposition in that year a system of reinforced concrete was exhibited by Lambot. In 1861 Coignet proposed a method of reinforced concrete construction. The first application of metal reinforcement for concrete by Monier was in 1867 in the construction of some very large flower pots. In 1868

RAPID TRANSIT SUBWAY, BOSTON, MASS.

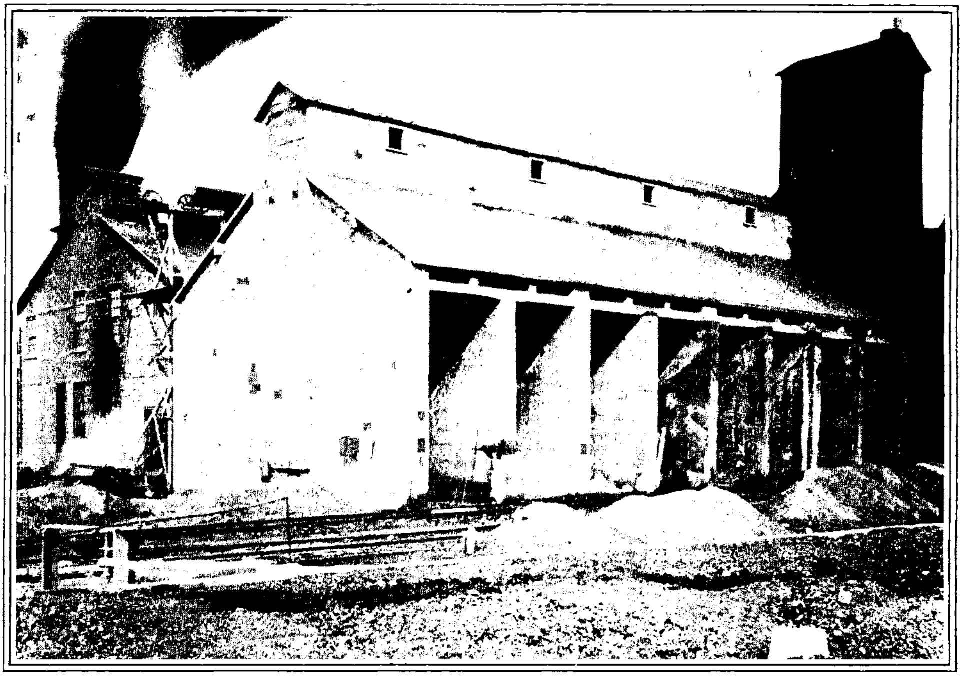
Monier obtained his first patent for reinforced concrete, but it was not generally used until after 1880, although in 1879 he again exhibited at the Antwerp Exposition a system of reinforced concrete construction.

The first reinforced concrete construction in this country is credited to W. E. Ward in 1875, who erected in New York City a house having the floors and columns of reinforced concrete. It should be noted that in 1876, Thaddeus Hyatt, an American engineer, published his experiments on reinforced concrete in the laboratory of Kirkaldy, London, England. The experimental work of Hyatt extended from 1870 to 1880. The first Ransome patent was taken out in 1882, and it was applied in the construction of his first building in 1884. Between 1891 and 1894 Moeller in Germany, Muensch in Hungary and Melan in Austria were pioneers in the development of reinforced concrete construction in Europe. The use of reinforced

DRAINAGE CANAL, NEW ORLEANS, LA.

concrete on a large scale began in Germany under the system of Moeller in 1893 and Rabits in 1898. Hennebique had built reinforced concrete floors as early as 1879. It was not, however, until 1892 that he obtained a patent for his system of reinforced concrete construction.

The last ten years has seen a very remarkable development in reinforced concrete construction. At first reinforced concrete was used largely in the construction of bridges, the first of which was built in this country over the Pennypacker Creek in Philadelphia in 1893, and for which I had the honor of inspecting the cement and other materials, as well as the construction of the bridge. From this beginning the use of reinforced concrete has developed rapidly and we find it is used in almost every conceivable form of construction. Large sewers, water pipes, reservoirs, coal bunkers,

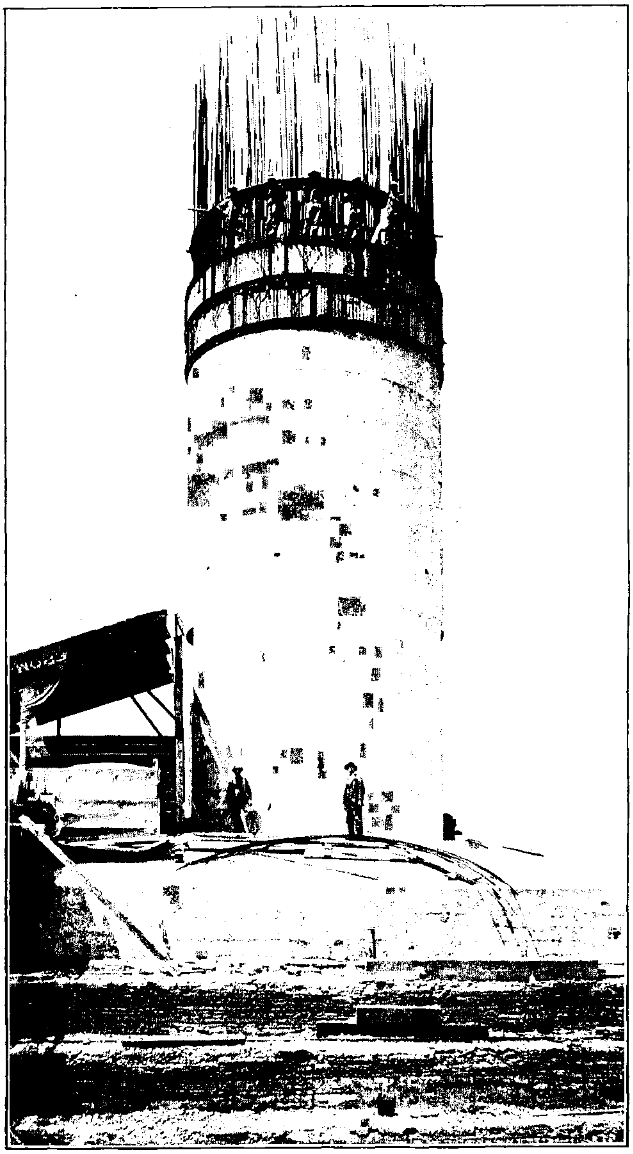


REINFORCED CONCRETE COAL POCKETS, BATH, PA.

pneumatic dams, chimneys, grain storage bins, bridges, buildings, being some of the many applications.

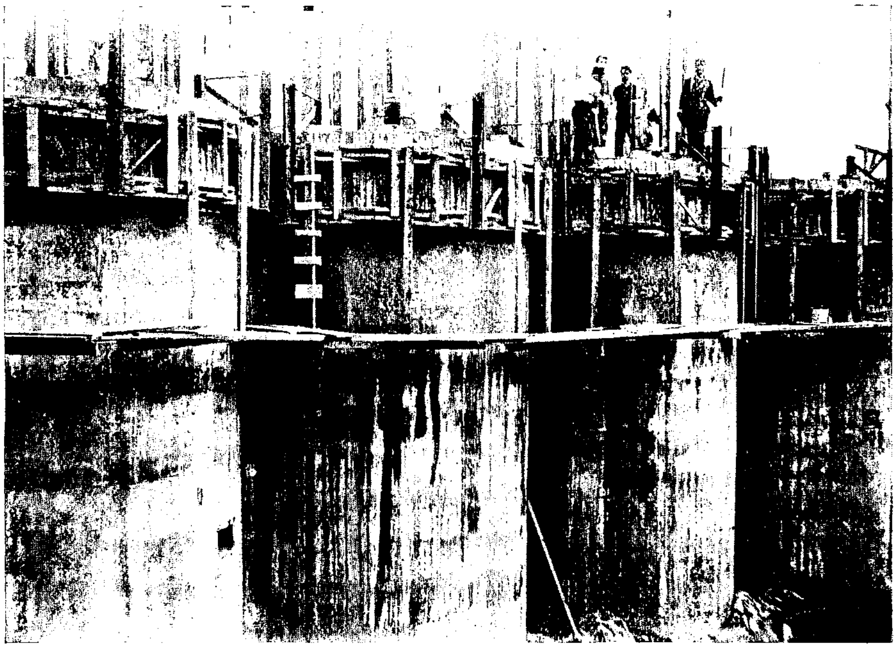
Experiments have been made in the Reclamation Service for its application in large reinforced concrete pipes of five feet in diameter and capable of standing upwards of 70 pounds in pressure, while one of the most novel and recent applications of reinforced concrete is for reinforced crib work, under the Frazer system, which it is stated costs a little more than timber cribbing, and which has been used extensively in Canada. Chimneys 350 feet in height have also been successfully

REINFORCED CONCRETE CHIMNEY, 350 FEET HIGH, 18 FEET DIAMETER, FOR COPPER SMELTER IN MONTANA.



REINFORCED CONCRETE CHIMNEY IN PROCESS.

constructed of reinforced concrete. The Harvard stadium, the baseball stand in Cincinnati, and the stadium of the Washington University at St. Louis are all novel examples of the use of reinforced concrete, while concrete ties reinforced in various ways have been in use for some time though they have not been satisfactory as regards cost. The cost of maintenance, however, has been found to be reduced to a nominal



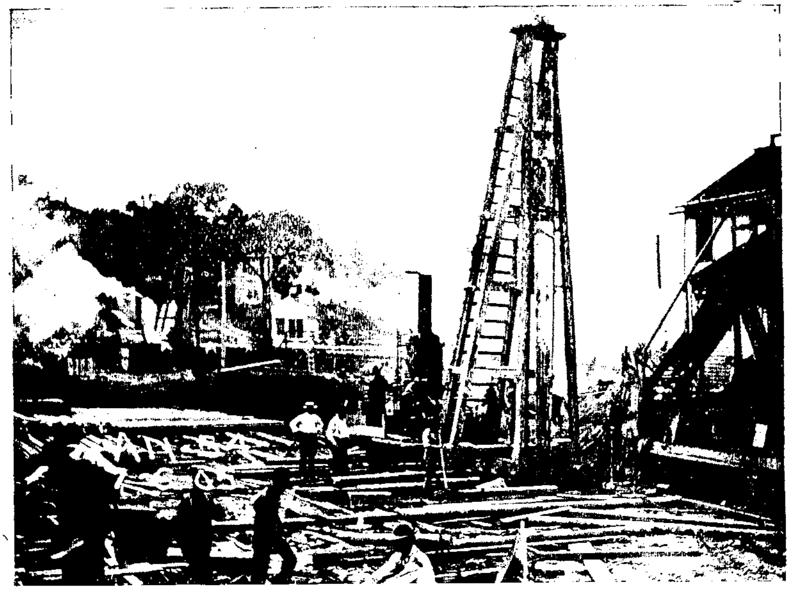
REINFORCED CONCRETE GRAIN STORAGE BINS, PHILADELPHIA, PA.

sum and all the alignment very easily maintained, which greatly offsets the first cost. The rigidity of the roadbed, however, has been a prime objection, and an effort is now being made to introduce an elastic cushion in the tie in order to overcome this objection.

It is in the erection of office buildings of considerable height that the development has been most remarkable. Buildings 18 stories in height are being erected in which the skeleton is of reinforced concrete. Considering that the use of steel for reinforcing concrete beams was not suggested until

1882, a development of this character is certainly remarkable and we have reason to pause and consider whether such extreme development is wise.

While visiting a large city recently, I had occasion to inspect a building several stories in height in which cinder concrete is being used in the structural parts. The contractor, in reply to my surprised query, stated that the building was still standing. This was indeed true, but what was the mar-



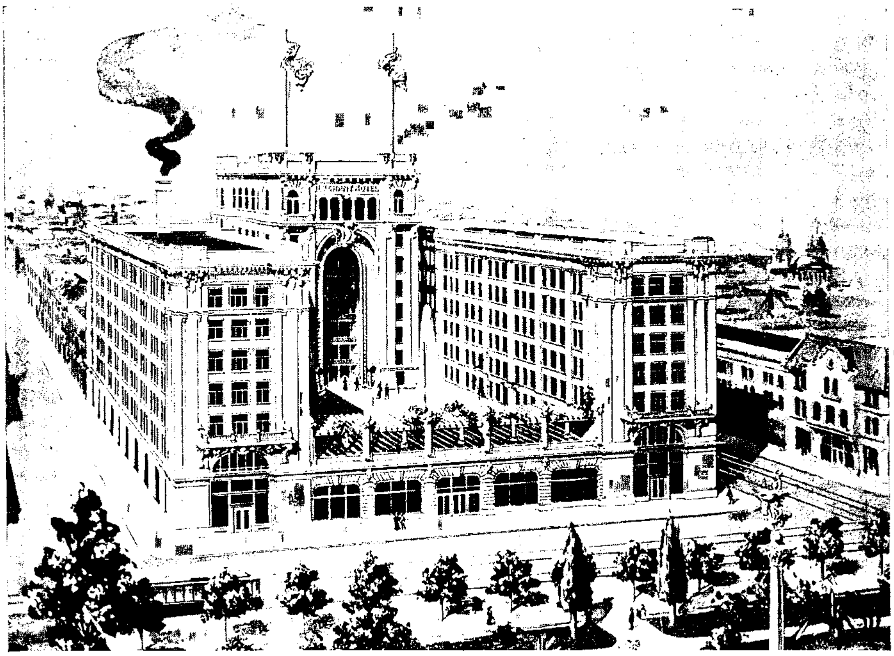
DRIVING A CONCRETE PILE.

gin of safety in this structure? As this concrete had a compressive strength about half of what could be expected from a fairly good concrete, the factor of safety had therefore been cut in half. In further explanation he stated that in order to compete with other contractors, he was obliged to use the same materials which they did. The use of inferior materials should not be permitted in reinforced concrete construction, and the present situation in the development of concrete and reinforced concrete is one that should be faced squarely. That it is possible to erect a sixteen story building of reinforced concrete has been demonstrated,—but we should have a better

INGALLS BUILDING, 16 STORIES, STRUCTURAL SKELETON, REINFORCED CONCRETE, OF CINCINNATI, OHIO.

knowledge of the properties of this material before such a practice becomes general. Ten years or less experience with a material in which chemical changes are constantly going on and which may be affected by the changes produced by expansion and contraction is hardly sufficient to enable us to obtain a thorough knowledge of its properties.

The American Society of Civil Engineers recognized the



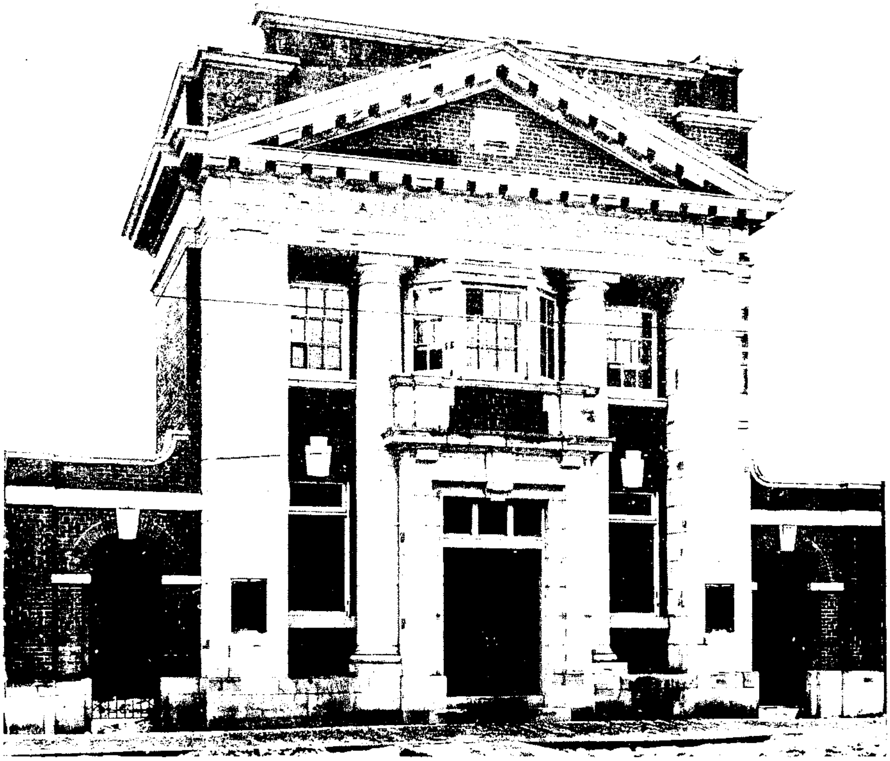
REINFORCED CONCRETE HOTEL, CALIFORNIA.

vital importance of this subject and recently appointed a committee on concrete and reinforced concrete, with instructions to affiliate itself in its work with similar committees of the American Society for Testing Materials, The American Railway Engineering and Maintenance of Way Association and the Association of American Portland Cement Manufacturers. After over a year's work they have found that:—

(1) Thoroughly reliable data upon which they can formulate a report as to the rules and formulae to be used in the design of reinforced concrete structures do not exist.

(2) That the results of the tests made in laboratories of the various technological institutions are not sufficiently comparable nor correlated for the purpose of obtaining these data; and

(3) That in order to secure the requisite data it will be necessary to conduct a complete series of tests in onè labor-



ORNAMENTAL WORK MADE OF PORTLAND CEMENT (CAST STONE.)

atory where the conditions are as uniform as it is practical to obtain them and where the personal equation is reduced to the minimum.

This requires considerable money. Fortunately the small appropriation made to the United States Geological Survey for the investigation of structural materials has been applied to this work and the investigations have been inaugurated under the direction of an Advisory Board on Fuels and Structural Materials by the United States Geological Survey in co-operation with the Joint Committee on Concrete and Reinforced Concrete of the American Society of Civil Engineers and affiliated societies. In the absence of reliable data and under the conditions in the present state of the art, the courage to erect eighteen story buildings must command our admiration. I do not wish to be deemed pessimistic or overly conservative, for my belief in the future of concrete and reinforced concrete is absolutely unshaken, and I feel that the use of cement will so expand during the next few years that it will go beyond the limits of its most ardent advocate, but I do wish to point out the dangers which will result from its indiscriminate and fool-hardy use and to protest against the people who rush in and guarantee ridiculous things in concrete construction.

Concrete fills an important and growing field, but it has its weaknesses and its limitations and they should be pointed out and recognized squarely by its advocates. It is evident to any one who delves into the subject that reliable data for use in design of concrete structures are very much needed, and the work the Joint Committee on Concrete and Reinforced Concrete is doing in co-operation with the United States Geological Survey should receive the encouragement and support of each one present, and I would ask you to use every effort in urging upon your Congressman the vital importance of securing an appropriation for the continuance and completion of this very important work, for the attainment of reliable and uniform data for use in the design of structures in concrete and reinforced concrete will insure a more rapid, safe and successful development in the use of cement.

National Association of Cement Users.

PROCEEDINGS

OF THE

THIRD CONVENTION.

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THE SUCCESSES AND FAILURES OF CEMENT CONSTRUCTION.

Annual Address by the President,
Richard L. Humphrey, M.Am.Soc.C.E.*

We are indeed in the age of cement, and it is apparent that this infant industry which burst its swaddling clothes but a few years ago has become a lusty youngster—its growth outstripping the dream of its most ardent supporters.

We are passing through an era of unparalleled prosperity which has occasioned an activity in the world of construction demanding enormous quantities of cement, thus advancing the yearly consumption to figures which are a hundredfold greater than those of a dozen years ago.

When Germany, our principal competitor, topped a yearly production of 20,000,000 barrels, we regarded it as wonderful, yet a half dozen years later our own production has doubled these figures and we now are the largest cement producing country of the world.

It is hard for even the cement user to follow the meteoric progress of the production and consumption of cement. A prog-

*Consulting Engineer, Harrison Building, Philadelphia, Pa.

ress so rapid that the friends of this material of construction must needs pause and consider the danger which may await a too rapid pace.

It was my pleasure a year ago to address this Association on the development of the industry and to indicate some of the uses to which cement was put. I shall utilize the time allotted for this address in pointing out the features of the great test—the San Francisco earthquake—which served to further establish some of its intrinsic qualities as a building material and to further point out some of the abuses to which it is subjected, which often result in failures of the structures in which it is used and which tends to retard the progressive development in its use.

As I took occasion to remark a year ago, cement has its weaknesses and limitations, and these should be faced squarely by its advocates and pointed out emphatically, in order to prevent abuse which tends to dim its unsurpassed qualities.

Of the materials of construction cement is at once the most delicate and the most valuable—a plastic material, whose properties we are only just beginning to appreciate and understand.

Its extensive use is not because its qualities are well developed and recognized, but because its cheapness renders it an effective competitor of other building materials both in strength and fire-resisting qualities.

Great catastrophes and overwhelming disasters of all kinds, while resulting in great hardship and suffering, teach lessons of incalculable value. On the 18th of April of last year the entire civilized world stood aghast at the appalling destruction which visited the city of San Francisco and vicinity—the result of a slip of the earth's crust.

To the constructor and user of the materials of construction the most interesting feature was the behavior of the various materials of construction under those unusual and rigorous conditions. This was a test of such unusual violence that only the structure begotten of first-class materials and design and honest workmanship could survive.

Flimsy and loosely erected structures were shaken to the earth and collapsed like houses of cards under the terrific wrenching and shaking of the earth.

Those structures which survived the earthquake test were, in many cases, subjected to a fire test exceeding in its intensity all the great conflagrations of recent years.

Many structures which successfully withstood the first test failed signally under the test which followed by reason of the inadequate fireproofing. Other structures failed under both tests, while a very few withstood both tests successfully.

The study of the relative efficiency of the various materials of construction under these conditions is most interesting. It is a generally accepted fact that no structure could withstand the stress produced by the movement of the earth on the "fault line." The effect of the shaking and vibrations of the earth in the territory affected could be resisted, and the secret is proper design, first-class materials and honest workmanship. In tall structures rigidity of construction and stiffness, the result of adequate wind and portal bracing, is absolutely essential. While reinforced concrete structures in the zone of seismic disturbance were few, these passed the test in a highly, satisfactory manner. Rigidity and stiffness and a high fire resistance, which are inherent qualities of this material, demonstrated how admirably they were suited to resist this extraordinary test.

This test seems to be greatest for structures built in low lands—on alluvial soil in the valleys of rivers—where the settlement of the earth under the earthquake vibrations was very great. On solid ground and rock formations the test was much less severe. Structures at points of great destruction such as Palo Alto, San José, Salinas, Santa Rosa, etc., were built on soft material. The buildings of Stanford University suffered severely, most of them being wholly or partly destroyed by the earthquake shock. The types of construction represented were stone, brick and stone veneer and concrete.

The buildings of the latter type passed the ordeal successfully and demonstrated the superior qualities of a material possessing great adhesive qualities.

The great concrete dam at Crystal Springs Reservoir gave additional proof of the substantial qualities of concrete, for, although within a few hundred feet of the fault line, it suffered no damage.

At Palo Alto and Santa Rosa the failure of concrete block buildings have been pointed out as examples of the failure of cement to withstand the test. At Palo Alto three cement block buildings collapsed. No other result could have been expected when the method of construction is considered. The blocks were laid up without a tie of any kind, and the floor joists and roof timbers either rested on or were built into wall without any tie.

Under the movements of the earth the walls were pushed out of line, the wooden members of the structure not being tied to the walls, there was no means of restoring the wall to its former position and it collapsed. In one of the buildings the gable end of the roof rested against the wall and served as a battering ram.

That such structures can be so built as to withstand earthquake shocks is evidenced by the building at Santa Rosa also built of cement blocks, but differing from those just referred to in that iron tie rods held the walls tightly to the floor joists and roof timbers. While the neighboring brick, stone and frame structures collapsed, this building was but slightly damaged along the cornice line. The destruction at this point was perhaps as great as that in any part of the territory affected by the earthquake.

At Mills College, just outside of Oakland, there was a structure of concrete, a bell tower eighty feet high with four-inch walls of reinforced concrete. This was not damaged in any way.

Another reinforced concrete structure was the Cyclorama in Golden Gate Park, which demonstrated the futility of attempting to successfully provide against earthquake shocks where the foundation is bad and the materials poor. The walls of this structure rested on a foundation made by leveling off the top of Strawberry Hill; the aggregate of concrete consisted of a hard shale, which made a very inferior concrete, and a careful inspection of the ruined structure shows that little else could have been expected under the conditions. In San Francisco proper, in the fire zone, the behavior of concrete was equally satisfactory, and there are many cases where concrete successfully passed both the strength and fire tests. There were but two structures of reinforced concrete, namely, the Bekins Van and Storage building and the Academy of Sciences. The former was in process of erection and had reached the second story, while the latter was an old structure. The walls of each structure were of brick and were cracked extensively by the earthquake, while the concrete remained undamaged, both structures being completely burned out, but the concrete was not damaged in the slightest degree. The columns in the Academy of Science building were cast iron, filled with concrete, and in one instance where the cast iron expanded and failed by cracking the concrete core remained uninjured.

Cinder concrete was most generally used for floor construction and behaved in an entirely satisfactory manner.

The failure of plaster (gypsum) and terra cotta to protect steel against fire was most general. The utter inefficiency of commercial terra cotta was everywhere apparent, while cement or concrete, properly applied, on the other hand, was entirely adequate for the purpose. I believe that a terra cotta tile can be made which, when properly applied, will adequately protect steel structures, but it is not so made commercially to-day.

I think, to the unbiased observer, concrete gave sufficient evidence of its ability to resist both earthquake and fire; its rigidity making it an admirable earthquake material, while its extremely low rate of conductivity for heat makes it a fire resistant of high order. The San Francisco earthquake, with the resultant conflagration, will be of inestimable value to the future constructor in furnishing reliable evidence of the value of the various classes of material, and the record is but another testimonial of the admirable properties of cement.

Its strength and durability, its cheapness in comparison with other materials of construction places it in a position in which its future is absolutely secure. We are not fully conversant with its properties, its strong and weak points, and it behooves us to go slow and not be precipitate in its indiscriminate and reckless use.

The bold design in reinforced concrete, when taken in connection with the lack of a definite knowledge of some of the factors required in such design, is venturesome to say the least.

Nor is this venturesome spirit confined to reinforced concrete alone. Plain concrete is used under conditions requiring reinforcement, and building blocks are used for purposes for which they are utterly unsuited and under conditions which are dangerous.

Wherever failures occur, it is generally cement that has to bear the blame. And on this material all the sins of omission or commission are heaped, and yet it should be noted that it is extremely rare that failures are traceable to the quality of the cement used.

Where an unbiased examination is made, the failure is generally found to be due to bad workmanship, improper design, insufficient strength and a too early removal of the forms for the construction or all of these, and many failures occur from improper material, insufficient mixing, improper consistency for effective tamping. In these days of machine mixing too little attention is given to the rigorous inspection of the process. As an illustration of this point I would state that on a large piece of work the system used in the mixing of the concrete was such that the sand was thrown in by one man, the crushed stone by another and the cement by a third, the latter being called away from his post, failed to perform his part, but during the interval the sand and stone went in with rhythmic precision. It is obvious what the effect of these batches of concrete would be and how fatally they would affect the strength of an important part of the structure. In another case which I have in mind the cement, sand and stone were fed automatically from hoppers so adjusted as to give the requisite proportion. At the time of this inspection the cement hopper had choked, but the sand and stone were flowing on, and the operator, who was totally unaware of the fact, remarked, when his attention was called to it, that he thought the concrete looked rather peculiar. Perhaps the greatest source of failure is the strength of the forms; too little attention is given to the design of these forms, and they are often made entirely too light for even normal conditions, and where a temporary load in excess of that for which the structure was designed comes upon it the structure is either dangerously strained or collapses. I have in mind cases where excessive quantities of cement have been stored on the green concrete structure and in one instance producing a collapse of the floor panel. Concrete of improper quality is often used, and I recently saw in New York cinder concrete consisting of one part of cement and five parts of cinders going into a reinforced concrete structure. Again, the length of time which should elapse before the centering is removed has a marked bearing on the question of failures. The time required for concrete to harden sufficiently to permit the removal of the forms is naturally a variable one, depending on the design, the weather condition, and the strength of the concrete. A concrete with a small percentage of cement will require a longer time to acquire the requisite strength than a richer mixture: it will also take concrete longer to harden in cold than in warm weather, and a beam of long span must be stronger than the one of short span before the form can be removed.

Another source of failure is the lack of attention to details, especially as regards connections in the erection of a structure. The structure may be properly designed with the requisite amount of steel, yet the structure may be fatally weakened by the character of the connections. A reinforced concrete structure should be practically a monolith—the tension members must be continuous in beams and columns.

It makes a material difference as to the length of the splice allowed in such columns or whether the splice in continuous beams is adequate.

I have in mind an instance which came to my notice of an enterprising laborer who, observing the rod in a column projecting out of the concrete in the column of a several story building, seized a sledge hammer and drove the bar down flush with the surface of the concrete.

The remedy for all this is inspection, most careful inspection.

No more unstable material is in use to-day than cement. From the moment it is reduced to an inpalpable powder it undergoes changes which seriously affect its quality. Unlike steel, wood, or similar materials, it does not stay tested and its quality must be ascertained before use.

When we consider the way in which so delicate a material is handled by unskilled laborers it is not surprising that failures should occur.

A steel beam or channel is fabricated at the mill and undergoes during the process of manufacture a most rigid and careful inspection, and in the erection again undergoes careful inspection. On the other hand, a concrete structure is fabricated on the site and is subject to little or, at the best, indifferent inspection and the unintelligent laborer contributes to the abuse.

The same careful and rigid inspection should be given the erection of a concrete structure as a steel structure receives, and until this done we may expect failures.

Amid the ignorance and wonder that attends the use of a new material the charlatan practices his art unchecked, new forms of patented construction are constantly springing into existence, many absolutely devoid of merit and the public are being proportionately humbugged and deceived.

Plans and specifications are generally prepared by the contractor and for every skilled, competent contractor there are many who are incompetent who do not hesitate to skin the work in order that they may finish it without loss of profit, having taken it at a figure entirely too low to admit of proper workmanship with first-class materials.

Such practices are wholly unnecessary, for first-class legitimate construction can successfully compete with other forms of construction, and there are many reliable concerns capable of executing such work.

Owners, architects and engineers are criminally responsible where they award work to irresponsible contractors, lacking in the requisite experience and knowledge for safe construction or who permit structures to be erected under the direction of competent persons who do not give the work their personal supervision.

Where the charlatan reaps his greatest harvest is through the medium of the beguiling literature giving strength values based on tests primarily made for the purpose of developing and exploiting the strongest features of the system for which he holds the patent.

Many concerns rush in with inadequate experience, acquiring this at the expense of their clients.

The present condition of the art of concrete or reinforced concrete construction is not unlike the condition of the iron business in its early history not so many years ago.

The knowledge relating to the construction of highway bridges was at that time largely vested in the contractor, and it was the practice for the contractor to submit bids for bridges based on his own plans and specifications, and the number of failures of highway bridges was directly attributable to this fact, and it finally drove the constructor into making his own designs and specifications, with the result that the contractor bid much more closely and intelligently on a definite plan and specifications, and failures in such structures became a thing of the past.

This experience, I believe, will be repeated in the case of structures of cement. In the meanwhile until our knowledge of the properties of concrete is more fully established, its strong and weak points more thoroughly understood; it behooves us to go slow and be more conservative and careful in its use. The failures which occur from time to time unquestionably hinder the development of the industry in that they cast doubt upon a comparatively new material and make builders cautious in its use.

I would repeat that we should recognize the weak points of cement and further see to it that its good points are not abused.

The comparatively few failures in concrete structures are allowed to overshadow the great number of excellent examples of well designed constructions of this class. And it should be noted that what failures there are occur during the process of erection and are almost invariably due to a too early removal of the forms or bad workmanship.

The failure of a structure of concrete by reason of improper design, bad workmanship or poor materials is no more an argument against the value of concrete for construction purposes than is the failure of a structure of steel under similar conditions an argument against the use of steel for structural purposes.

We may expect failures as long as incompetent men will undertake to design structures in concrete and unskilled and ignorant persons will attempt to "skin" the work for the purpose of increasing their profits; and it will only be the continual loss of life that results from these failures that will bring the authorities to such a realization of their responsibilities as will result in laws which will properly safeguard the public.

It will only be by determined action that the present abuses can be curbed and the fair name of concrete preserved.

It is the duty of every user of this material, of every friend to join most heartily in the cause. Let each of us put our shoulder to the wheel, thereby controlling this rapid movement in the application of cement to constructive use lest it get away from us and go on to destruction. We should not be afraid to state the truth, even though it hurts; we should by all means be honest, and not hold malice toward those who frankly call our attention to the few weaknesses in the most magnificent building material at the command of the constructor.

NATIONAL ASSOCIATION OF CEMENT USERS.

PROCEEDINGS

OF THE

FOURTH CONVENTION.

This Association is not responsible, as a body, for the statements and opinions advanced in its publications.

THE YEAR'S PROGRESS IN THE CEMENT INDUSTRY AND THE WORK OF THE ASSOCIATION.

ANNUAL ADDRESS BY THE PRESIDENT,
RICHARD L. HUMPHREY, M.AM.SOC.C.E.*

It annually becomes the duty of your presiding officer to deliver an address, and at times this can best be utilized as an opportunity to present to the Association matters worthy of serious consideration.

In view, however, of our extended program, replete with subjects of interest, it is expedient that I should speak briefly concerning such matters as seem to me especially important. I will, therefore, indicate briefly the problems that have received special consideration and refer to the progress made in the use of cement since our last convention. I shall also bring to your attention matters that have developed during the three years in which I have had the honor to be your President. In view of the fact that the development of the cement industry has been so rapid, it is not surprising that the growth of an Association concerned with its use should be equally so. While cement is not a new material, its use extending back to many thousands

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of years before the Christian era, it has many new applications in construction work.

All these facts have been brought to your attention in previous annual addresses and should, therefore, be very familiar to you. The frenzied efforts made to use cement in constructive work, without adequate knowledge of proper structural methods, have resulted in much harm, but, fortunately, there has been a turn towards conservatism, which has effectually checked this tendency and real progress is now being made. Many obstacles are being overcome and probably the greatest will be removed when the discriminating and antiquated municipal laws which exist in so many of the larger cities of this country, with their unjust and absurd limitations concerning the use of concrete, have been replaced by rigid but just revisions based on our present knowledge. I think it is an encouraging fact that municipalities are quite as earnest in their efforts to secure a revision of these existing laws as are those interested in the material against which they discriminate. The cause of concrete will be materially benefited by the adoption of laws that will prevent criminal construction by irresponsible parties.

One of the greatest handicaps in the development of the use of cement for constructive purposes has been in the wide dissemination of claims by over-zealous enthusiasts that concrete structures can be erected by unskilled laborers. This fallacy is being rapidly removed and the friends of concrete should emphasize the fact that, like any other building material, it must be carefully and intelligently handled in order to produce the best results. It is also to be regretted that the frank statements on matters pertaining to this subject by qualified authorities should be maliciously distorted by the advocates of other building materials, who feel that they are being injured by its increased use. But, in spite of these hindrances, concrete is being used more largely each year, and those who attempt to block this development find that, like a boomerang, such action is reacting to their own injury.

The creation of the office of Inspector of Concrete by municipalities for the purpose of enforcing the building laws is another hopeful sign and marks the best progress that has been made during the year. It should not be forgotten that the existence of these inspectors, whose tenure of office is dependent on political conditions, can be of no great service, except insofar as it serves as a constant reminder of the care that should be exercised in building construction.

Another line of development desirable in the revision of our building law lies in provisions which result in more fireproof structures. The study of the fire losses of the world afford much food for thought. The per capita losses from fire in this country, extending over a period of five years in 252 American cities, amount to over $3.10, as against an average per capita loss of 61 cents in 43 of the principal cities of Europe. While we spend large sums of money yearly fighting fire, foreign countries spend materially lesser amounts in enforcing laws which will prevent such fires. In the introduction to our consular reports on "Insurance in Foreign Countries," there appears the statement that "In Europe the fire insurance laws are remarkable, chiefly because they compel insurance in some countries, while in all cities they prevent great losses by insisting on the erection of only stone and brick buildings. The fire department systems are ridiculously inadequate as compared with those of American cities, yet the net results are better. There is nothing in which American municipal government makes so unfavorable a showing, in comparison with those of European cities, as in all that relates to the construction of buildings and the enforcement of regulations which minimize the danger of losses of life and property by fire."

At times great conflagrations arouse public sentiment against faulty methods of construction, but the inadequacy of municipal laws prevents any real progress being made as the result of the lessons that such disasters teach. The San Francisco fire, in three days, caused a loss to the many insurance companies who were doing business in that city which exceeded their profits for many previous years. Had the buildings in that city been properly constructed under adequate building laws, such a condition would have been impossible.

No material is absolutely fireproof, the fire resistive qualities of the materials of construction is a question of the degree of temperature to which they are subjected, but, of all materials of construction, concrete affords one of the best for such purposes. The continued use of materials which have been shown to be inferior in the construction of so-called "fireproof" buildings in our large cities, and the continuous discrimination against materials known to possess superior qualities, is a matter of constant wonder. There is a fallacy which is quite prevalent and which should be removed, and that is the feeling that concrete, in itself a fireproof material, requires no protection against fire when used as a structural material. The same protective coating of concrete should be applied in the case of a structure of concrete as would be required in case of a similar structure of steel.

The revision of building laws providing for rigid inspection of materials and structures by competent persons is most earnestly desired and is a remedy which should be generally applied.

Concrete, by reason of being a comparatively new material, especially as far as its application for structural purposes is concerned, receives greater attention than all the other building materials, and it is not surprising, therefore, that any damage which occurs in the construction of such a structure should gain the widest publicity, while structures of other materials which collapse, rarely receive passing attention. We cannot emphasize too strongly the fact that it is only during construction that concrete collapses occur, and that such collapses are almost invariably occasioned by improper design, workmanship or materials. Concrete structures once completed do not collapse, but stand as monuments of durability, strength and economy. The enemies of concrete are continually endeavoring to create distrust and a feeling of insecurity concerning completed structures by suggesting the possibility of collapse. Fortunately, the ever-increasing and numerous structures of concrete entirely satisfactory in every way tend to disprove the statement and remove the feeling of distrust. I believe that all fair-minded persons now realize that the dangers in the use of this material do not differ from those connected with other building materials, and exist only during the process of construction. On the whole, I think we may congratulate ourselves on the progress made in the firm entrenchment of concrete as a permanent, cheap and reliable material of construction.

So, too, in our own Association, we have cause to feel grati- fied that it has been equally successful in becoming a valuable and permanent organization and has already performed an invaluable task in disseminating a knowledge of the proper use of cement through conventions and proceedings and the practical demonstrations of the uses of cement at its annual exhibitions. The best field of the Association lies in advancing and developing the practical problems involved in the use of cement. It has a field of its own in bringing theory and practice together, reconciling the differences which may exist, thereby enabling the theoretical man to better appreciate the practical problems involved and bringing the practical man to the proper appreciation of the value of theory. The membership should comprise, as it does at the present time, the engineer and the architect, the manufacturer and the contractor and his assistants.

The Association needs larger funds for its work in order that those things which your Executive Board finds so necessary for the good of the Association, may be accomplished quickly and effectively. The Association needs an annual fund made up of contributions from the corporate interests composing a portion of the membership of this Association, a fund annually guaranteed and adequate for the Association's needs. This would permit the employment of paid assistants, who would devote their entire time to the work. By this means, the membership could be materially enlarged and the funds from the additional dues would gradually render the support of contributing members unnecessary, and eventually they could be relieved of their obligations. I think the development of this Association, as shown by its membership list, has been marvelous. The net result of the convention of 1905 was 161 members; that of 1906, 218; of 1907, 450, and I believe the result of this convention will be nearly 1,000. There is no reason why this membership should not be many thousands.

The proposition to acquire additional revenue through an increase in the dues is, in my judgment, unwise. Let us maintain our dues as at present, so that everyone interested in the cement industry can afford to be a member.

We want, above everything else, to maintain this Association as a clearing house for practical ideas. We want to be able to ublish the results of our annual deliberations promptly so that those members who are unable to attend our conventions may be able to secure the papers and discussions at the earliest possible moment. It is not dignified for the officers of this Association to be compelled to secure funds for this purpose by soliciting advertising.

The loyal support of our members and exhibitors at our annual convention is a matter of great gratification and especially should we feel grateful to the technical press for their ever hearty and unselfish espousal of the cause of the Association. The Association exists purely as an educational medium; this, also, is the purpose of our technical papers. The cause is a common one, and it is natural that these mutual interests should result in powerful co-operation. All the interests united in this cause stand together for power and truth. If for one moment we falter or pull apart, our cause will, in a large measure, be lost.

The officers of this Association at the present time serve the Association at a personal sacrifice and with unselfish devotion. It is not fair that so much of their time and money should be required. The large sums of money which are annually expended by exhibitors are small in comparison with the yearly sacrifices of these officers.

In conclusion, I wish to say that, in my judgment, the future success of this organization depends upon the employment of men who can devote their whole time to the work. Such assistants should be under the direct guidance of the President, who is the executive head of the organization, and is the medium through which the will of the Association can be carried out.

This Association must grow, and we must meet these new demands. The magnificent exhibition of 1908 testifies to its usefulness and means should be provided for its larger development on business principles and on broader lines.

National Association of Cement Users.

PROCEEDINGS

OF THE

SIXTH CONVENTION

THE USE OF CONCRETE IN EUROPE.

Annual Address by the President,
Richard L. Humphrey.*

In the rapid development of the use of concrete in this country, there is a tendency to lose sight of the work of other countries, and it might, therefore, be of interest to indicate the essential differences, the methods employed and the points of excellency in the results obtained. It has been my good fortune to inspect many of the important concrete structures in this country and, during the last four months of the past year, to visit the principal cities of Europe, where, under the guidance of representatives of the various concrete associations and of companies engaged in concrete construction, typical examples of the best work have been inspected. It has, of course, not been possible to see all work of importance, but a sufficient number of structures both in this country and in Europe have been visited to obtain such knowledge of the prevailing conditions as to permit of an intelligent discussion of the subject.

It would seem that the conditions affecting the use of con-

* Consulting Engineer, Philadelphia, Pa.

crete and reinforced concrete are the same the world over. The same problems that confront us here are present on the other side of the ocean. Certain striking differences in the design of structures result from economic conditions as affected by the cost

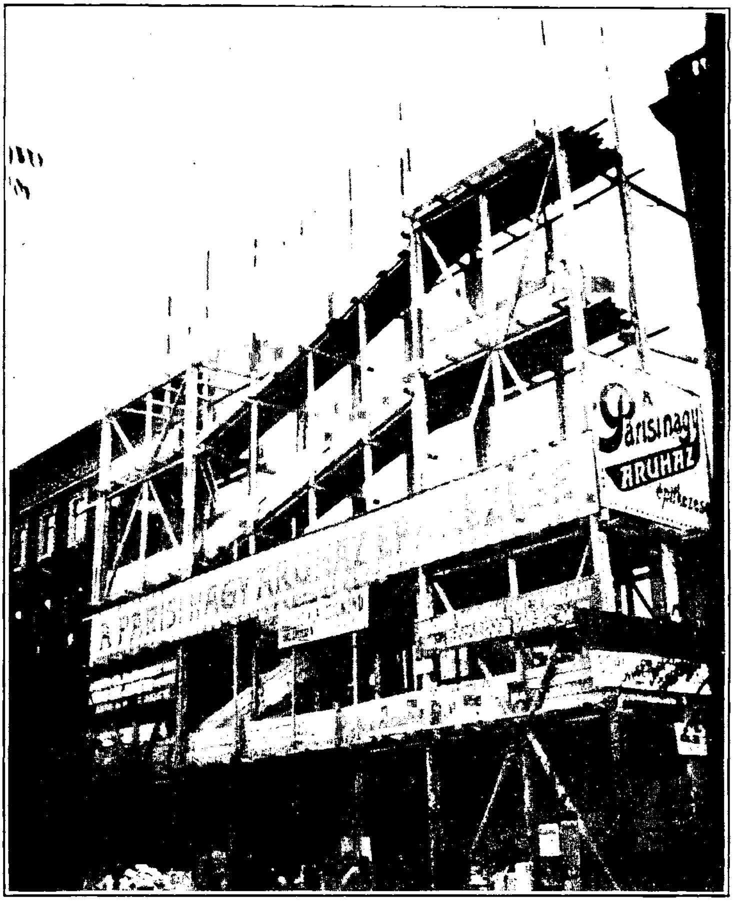

FIG. 1.—METHOD OF SCAFFOLDING IN EUROPE.

of labor and materials, as will be subsequently pointed out, while the presence of a large number of skilled laborers and mechanics contributes no little to the success of concrete construction in Europe.

In but few respects are the foreign constructors in advance of this country. The most striking instance is in the artistic treatment of the material, which results in many pleasing structures. It would seem that they had also acquired the ability of treating concrete as a plastic material and applying to it an adequate knowledge of the laws of mechanics of materials, together with a rational use of the laws of design. The result is graceful, well-balanced structures, in contrast to some of our cumbersome, ill-designed structures, distinctly lacking in archi-

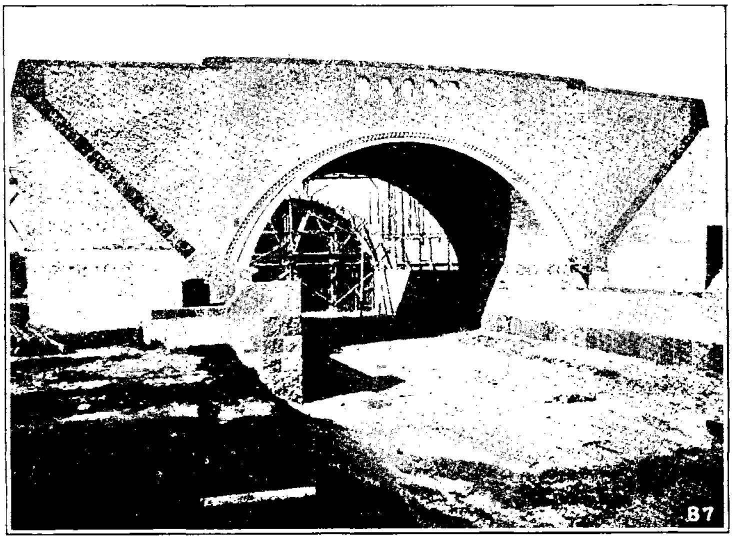

FIG. 2.—RAILROAD BRIDGE, MÜHLHEIM, GERMANY.

tectural effect. The American constructor, either by reason of a lack of knowledge of the properties of concrete and reinforced concrete, or of the laws of design, has in many cases resorted to an excessive use of materials, often decreasing the factor of safety in his efforts to increase it.

This may, perhaps, be explained on the grounds of conservatism, since the use of reinforced concrete in building construction is of recent application, and the scientific investigation of its properties has, for the most part, dealt only with elementary phases of the subject. Much work has yet to be done in the field of investigation before our theories as to the laws pertaining to reinforced concrete construction can be classed as more than tentative deductions from the elementary data now available. As the result of a visit to the principal laboratories of Europe, it appears that a great deal more research work in concrete has been done in Europe than in this country. It is possible that, as a result of this data, the foreign constructor has acquired more confidence in the use of concrete, which accounts for many applications which appear daring.

Economic considerations, as previously stated, are responsible in part for the graceful appearance of many of the structures.

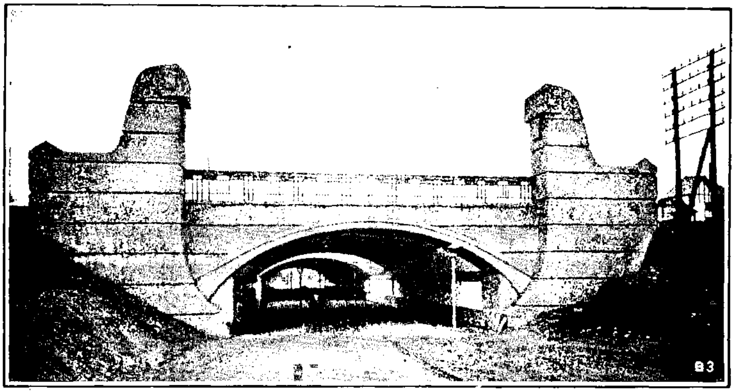

FIG. 3.—RAILROAD BRIDGE, COLOGNE, GERMANY.

For, by reason of the higher cost of materials as compared with the labor, the designer strives to save all material not necessary for the strength of the structure, and thereby improves its appearance.

In the matter of consistency of the concrete there is an astonishingly wide range of practice. In this country the pendulum has swung from a very dry mixture requiring much ramming to compact it, to a very wet mixture that cannot be rammed. Fortunately, the pendulum is now reaching a middle position, and it is good practice in this country to use a medium consistency that will readily flow, without separation of the aggregates, into all parts of the forms and around the reinforcement through the medium of a slicing tamper.

The practice in Europe covers all conditions of consistency. In Germany the concrete is quite stiff and receives a great deal of tamping; in France it is used so very wet as to require no tamping. In the other countries the concrete is either quite wet or very stiff. None of them appear to have reached the practice of using a concrete of viscous consistency, or one in which there is a maximum of coherency. Such a consistency, in my judgment, is the proper one, and can only be attained through the use of

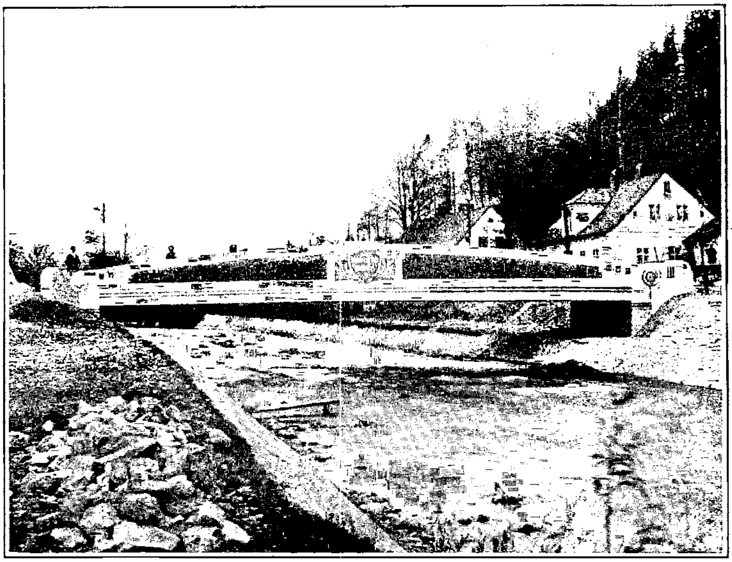

FIG. 4.—FRANZENS BRIDGE, BUCHELSDORF, AUSTRIA.

small, well-graded aggregates and thorough mixing by machinery, using a minimum percentage of water. This consistency will insure great homogeneity and maximum density, will facilitate filling of the forms, and, therefore, result in better finished work. Concrete of this consistency also hardens more rapidly because of the greater density and the minimum percentage of water used, thus permitting the forms to be removed more quickly. Where surface finishes are desired, the finer aggregates produce a surface more readily worked.

In the handling of cement mortar and concrete, the German laborer seems to possess a better appreciation of the material, for, while using a very dry mixture, he works it into a consistency which produces surfaces showing a minimum amount of hair cracks and crazing. The satisfactory condition of the plastered surfaces of the buildings in Europe is due largely to the skill of the workmen. By reason of the poor quality of the building brick available it is the almost universal practice to plaster the surfaces with a Portland cement mortar in which is used a small quantity of lime paste. For this purpose the rough

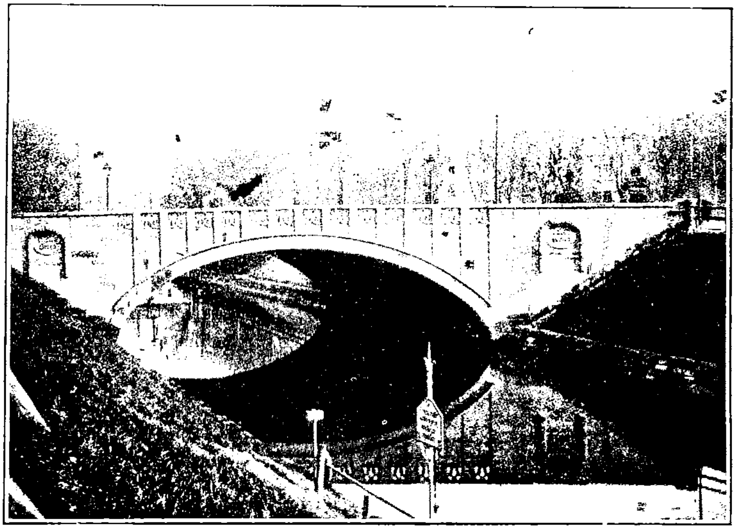

FIG. 5.—BRIDGE OVER AAR, STRASSBURG, GERMANY.

bricks are laid with large joints only partly filled with mortar; the plaster is worked into this joint and of a thickness just sufficient to coat the surface of the brick. An examination of many plastered surfaces in various foreign countries did not reveal any that showed the objectionable hair and shrinkage cracks that are so general in this country, particularly in our northern climates.

The cheapness of labor in Europe permits practices uneconomical in this country. The limitation in the height of buildings, generally to five stories, has prevented the development of methods for handling materials, which becomes a problem in the erection of buildings of many stories. As a result, it is in Europe a common practice to carry the mortar or bricks in tubs, on the head, up inclined runways, in many instances the work being performed by women. In only one instance did I see an elevator used for this purpose, and this was in connection with the erection of an addition to the Telephone Exchange Building in Warsaw. This building consisted of brick bearing walls, with reinforced concrete walls and columns, and was fifteen stories high, being one of the highest buildings in Europe. This fact is

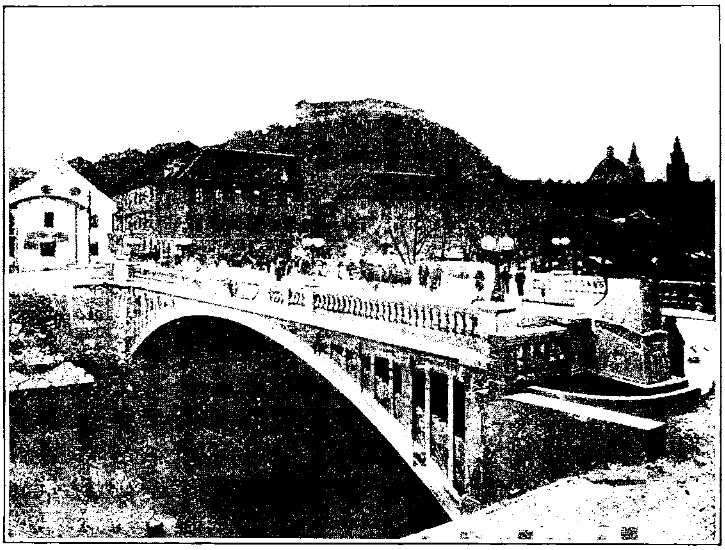

FIG. 6.—KAISER FRANZ JOSEPH BRIDGE, LAIBACH, AUSTRIA.

remarkable because of the prevailing limitation of height, and; further, because this unusually tall structure was of reinforced concrete. An interesting feature in the scaffolding is the general use of round timbers for the framing and the tying of these together, instead of nailing. This type of framing can be used many times and seems to be preferable to the square timbers so common in this country. It would seem that, in view of the growing scarcity of timber and the cost of scaffolding, some similar methods looking to prolong the life of such material could be very profitably applied in America. The view given in Fig. 1 shows the characteristic method of scaffolding in vogue throughout Europe, and attention is called to the tying of the round timbers forming the framing, and to the side planking along the runways, which prevents material from dropping into the street.

In Europe, as in this country, one of the earliest uses of concrete was for sidewalks, which are quite as general as they

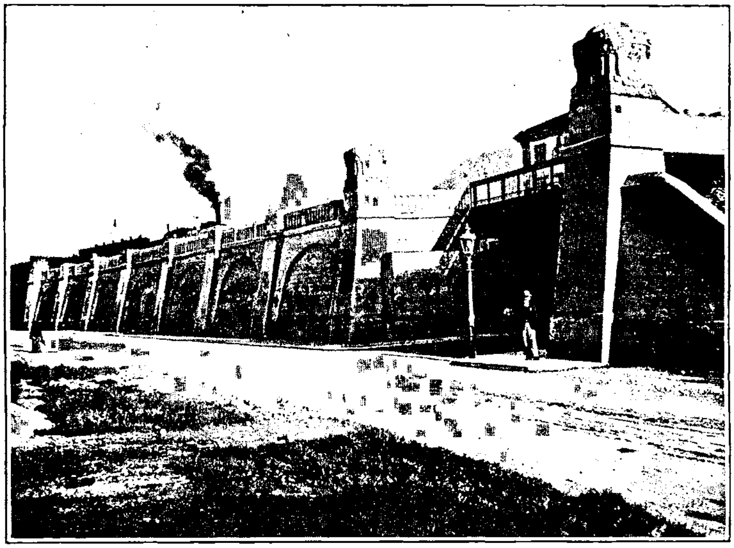

FIG. 7.—RETAINING WALL ALONG LINE STATES RAILWAY, SALZBURG, AUSTRIA.

are in America. The use of concrete for massive work, such as abutments, piers and retaining walls, is also quite common. In the latter, however, reinforced concrete particularly is being used, with a resulting economy over massive construction. In construction of bridges the earlier designs were, as is the case in this country, massive in character, but as the designer acquired confidence, the structures have become more graceful until to-day, light, graceful and pleasing structures are the rule. However, even in massive bridges, the artistic spirit prevails. The paneling of the soffit of the arch, the presence of a beading along the

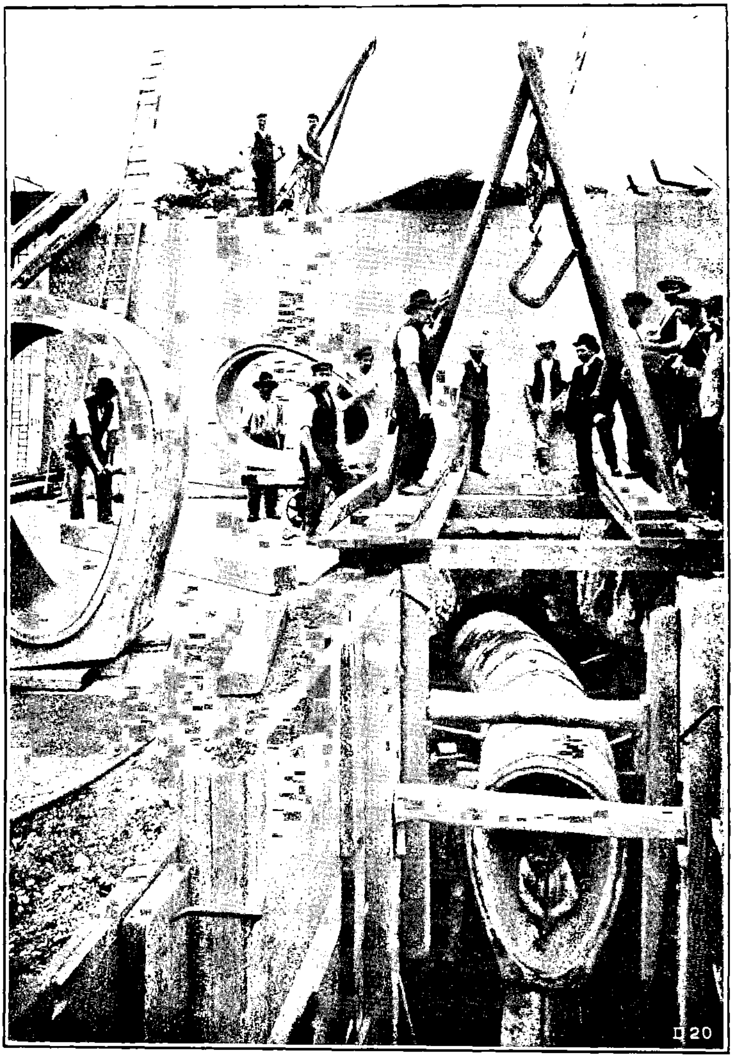

FIG. 8.—CEMENT PIPE BEING LAID IN HAMBURGER STREET, DRESDEN, GERMANY.

intrados, and a treatment of the surface so as to produce uniformity in texture, as indicated in the view of the railroad bridge (Fig. 2), are used with pleasing results. The deep horizontal joint at regular intervals, serving as a break for each day's work, is also utilized to advantage (Fig. 3). The wide use of concrete in bridge construction in Europe is due largely to the cheapness of material, facility of construction, and the economy in maintenance.

Prof. F. Schule, chairman of the commission in charge of

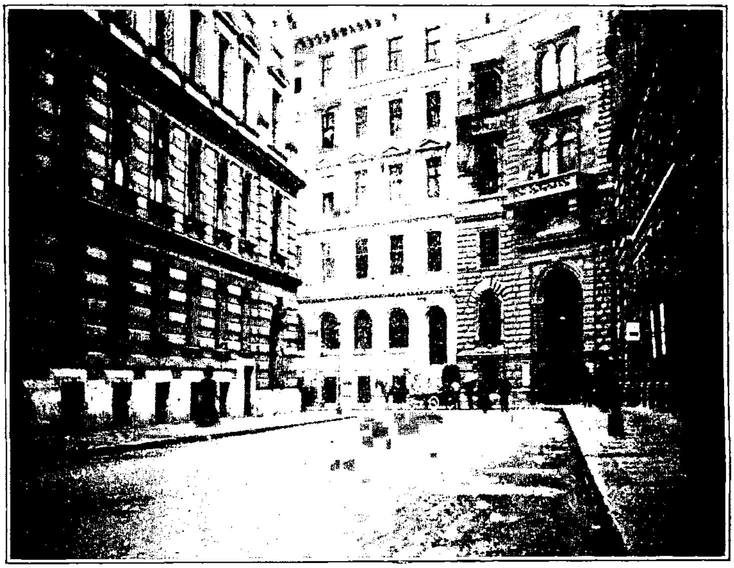

FIG. 9.—CONCRETE PAVEMENT 3 YEARS OLD, ROCKGASSE, VIENNA, AUSTRIA.

the erection of a bridge of large span at Luzerne, Switzerland, stated that competitive bids were received for steel and reinforced concrete, and that the bridge would probably be constructed of reinforced concrete because of the lower cost. Its cheapness in construction, together with the adaptability for obtaining pleasing structures, has made concrete one of the most popular materials of construction for bridge work. Because of these advantages, and the fact that there is practically no maintenance required, it is preferred even where the cost may be a trifle greater than for other forms of construction. In addition to this, concrete increases in strength with age, and the structure itself becomes more pleasing under the influence of the weather, just as the weather-stained stone bridge is much more attractive than it was immediately after its completion.

It is the practice in Europe to ornament bridges much more elaborately than here, and even small, unimportant structures are given as much attention as the more important ones. One fre-

FIG 10.—CONCRETE PAVEMENT UNDER CONSTRUCTION IN HASNER STREET, VIENNA, AUSTRIA.

quently sees statuary at the approaches, and a well-designed ornamentation which adds materially to the beauty of the structure. A good illustration of the attention given to unimportant bridges is that of the Franzens Bridge (Fig. 4), in which the paneling and the ornamentation at the ends should be noted. In the bridge over the Aar (Fig. 5), the scheme of ornamentation is much more elaborate, with proportionately pleasing results. The possibilities of concrete for bridge construction, both as regards permanency and ornamental qualities, is illustrated in the

Kaiser Franz Joseph Bridge, shown in Fig. 6. The bronze statuary at the approaches and the ornamentation of the main portions of the bridge, which is of graceful design, show the possibilities of the material. This bridge is of 33 meters (108.27 feet) span and 15 meters (49.22 feet) wide.

In this country there are some notable instances of ornamental bridges of this character, among which may be mentioned the Connecticut Avenue Bridge, over Rock Creek, Washington,

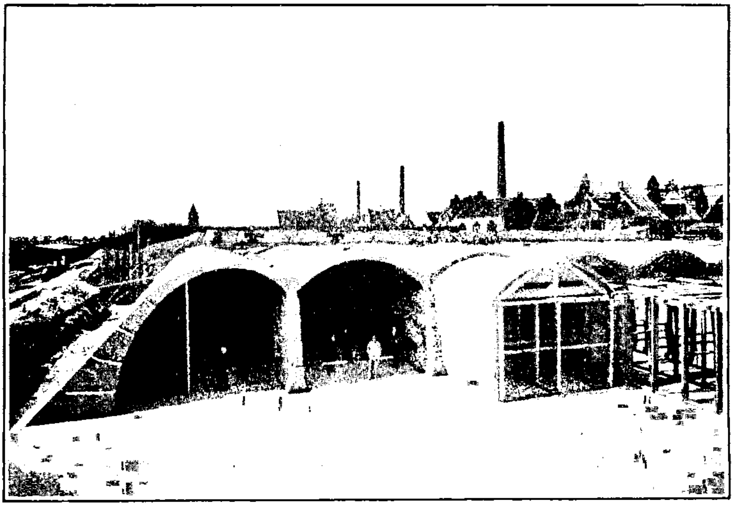

FIG. 11.—CONCRETE FILTER BEDS, BERLIN WATER SUPPLY, LICHTENBERG, GERMANY.

D. C., with its imposing lions of concrete at the approaches, and the unusual color effects obtained through the use of crushed granite for the concrete in spandrel walls, producing a light blue-gray color, and of Potomac gravel in the arch rings, piers and abutments, producing a buff color. The Walnut Lane Bridge,* over the Wissahickon Creek in Fairmount Park, Philadelphia, Pa., one of the largest spans of concrete in the world, is another excellent example of the artistic use of concrete. This bridge was constructed of concrete because the cost was lower than for any

*A reproduction of this bridge in color is given in the *Proceedings*, Vol. V, p. 173.

other form of construction. This bridge serves also as an example of the graceful effects which can be obtained through the economical use of concrete, and it is fair to state that the bridge itself would not present such a beautiful appearance if the spandrel arches had been cast solid.

It should be noted, however, that while there are a number of beautifully designed bridges in this country, in Europe there are many such, which fact may be explained as the result of the high development of the artistic sense in the older countries of

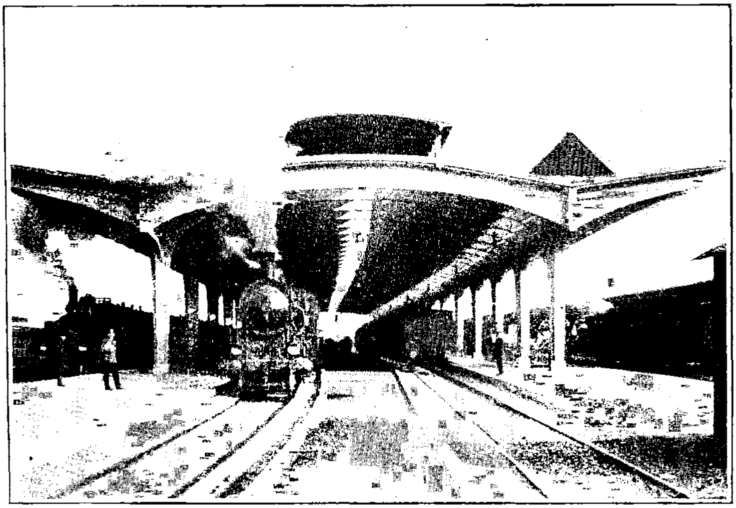

FIG. 12.—REINFORCED CONCRETE TRAINSHED, NUREMBERG, GERMANY.

Europe. It is this artistic spirit that makes it essential to finish a structure, and this leads to the ornamentation of even such structures as retaining walls, as illustrated by that along the lines of the State Railway in Salzberg, Austria (Fig. 7). The ornamental caps that surmount the walls at the street intersections, bearing the imperial arms, the water fountain in one of the bays, and other ornamental features, render attractive what would otherwise be an unsightly wall.

It is this treatment of structures of concrete so as to render them more pleasing to the eye, especially those structures whose chief function is utility rather than ornamentality, that constitutes one of the essential differences between the work in America and Europe. Some attempts have been made in this country to render the surface of walls, abutments and similar structures more

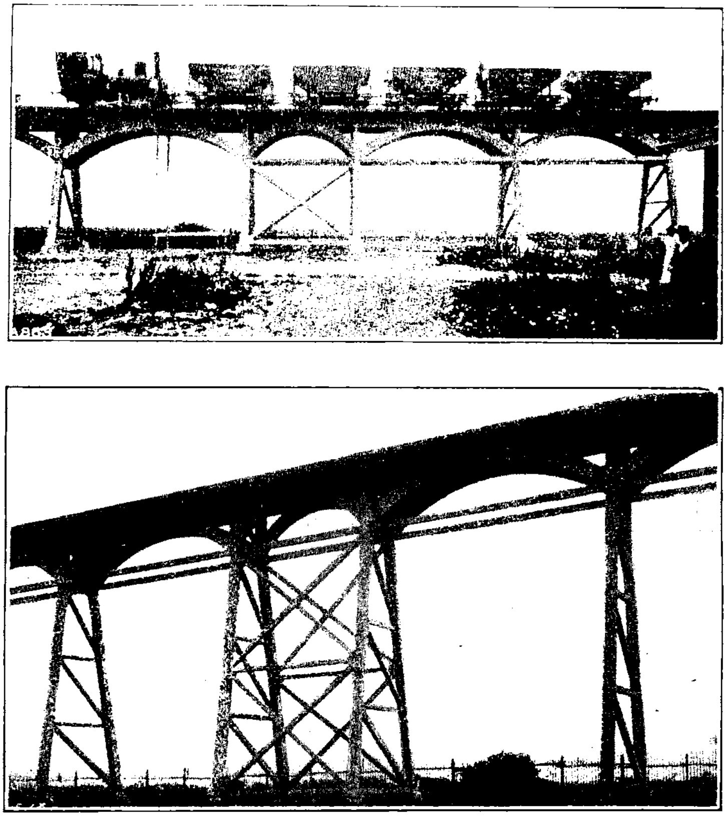

FIG. 13.—REINFORCED CONCRETE TRESTLE, MUNICIPAL GAS WORKS, COPENHAGEN, DENMARK.

pleasing, among which the process of removing the marks of construction through the scrubbed surfaces used in connection with the construction of bridges and other concrete structures in Philadelphia may be cited.

Concrete is quite generally used for sewers in foreign countries, where it is the practice to line the invert with stone, vitrified brick or tile. There are in use many concrete sewer pipes, both egg-shaped and circular in form, and are, in general, cheaper than brick and other clay tile. One of the best plants for the manufacture of cement pipe visited was that of Dyckerhoff & Widman, located in Amöneburg, near Biebrich, on the Rhine. These pipes have a density so great that they will not readily absorb water, and the pipe rings when struck with a

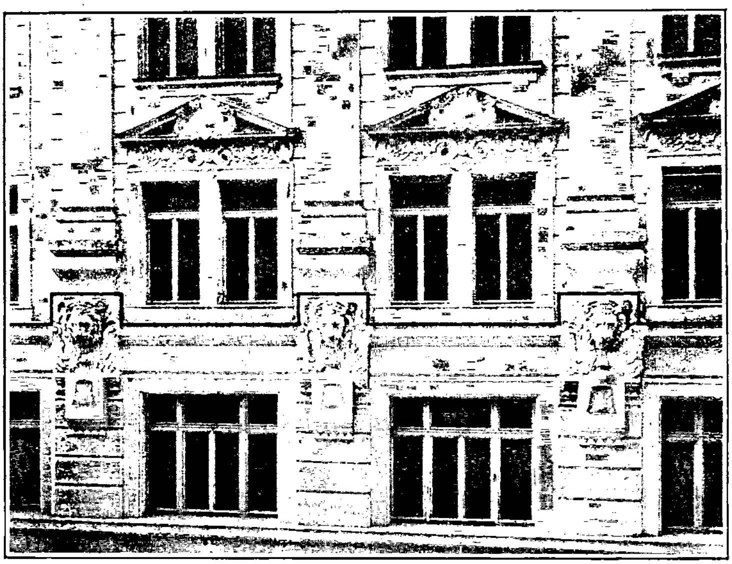

FIG. 14.—FACADE OF HOUSE, VIENNA, AUSTRIA.

hammer. A fairly dry mixture was used and the pipes were molded under heavy pressure, so applied as to rub the materials into position.

A plant in Sweden, near Mälmo, also produces, in a similar manner, pipe of equally good quality. The careful selection and grading of the aggregates, thorough mixing with a minimum percentage of water and molding under high pressure seem to be the secret in the successful production of pipe of this character. Cement pipe made by this process was exhibited in the Louisiana Purchase Exhibition, in St. Louis, and were by far the best that had heretofore appeared in this country. These pipes were manufactured in Europe and shipped to St. Louis. That they were not damaged by this transportation is evidence

FIG. 15.—FACADE OF HOUSE, VIENNA, AUSTRIA.

of their good quality. The contrast between the quality of this pipe and the quality of most pipe produced in this country is so great that it behooves us to exert our best efforts to secure pipe of better quality, for, by so doing, many of the troubles now confronting the pipe manufacturers will be eliminated. The quality of this pipe is also due to the care exercised in curing and aging; they are rarely shipped for use before sixty days, and generally not until ninety days, after molding.

Attention is directed to the egg-shaped sewer in Hamburger Street, Dresden (Fig. 8), which serves to show the character of the joints and the method of handling. In many parts of Europe may be found concrete sewers that have been in constant use

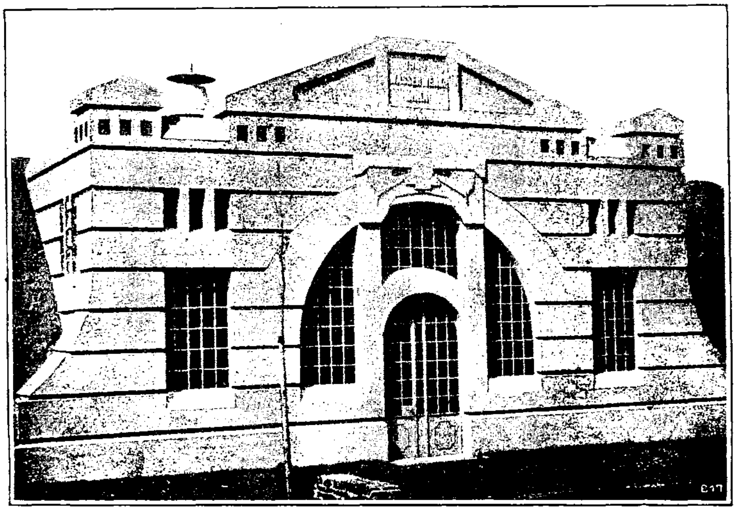

FIG. 16.—ENTRANCE, CITY WATER WORKS, UNNA, GERMANY.

for more than twenty-five years. I examined a cement pipe in Vienna, more than twenty-six years old, which was in excellent condition. Under conditions of heavy scour it seems to be the common practice to use vitrified tile for the smaller sewers, and to pave the invert of large sewers with vitrified brick or granite block.

In many cities the laws either prescribe against or limit the percentage of acid or alkali allowable in the waste water of manufacturing plants. Experiments were in progress in a number of places for the purpose of determining the effect of a tar coating as a preservative for cement pipe against the action of alkali and acid. These experiments had not proceeded far enough to permit conclusions to be drawn. The use of cement pipe seems to be more general in smaller towns, where it answers the purpose admirably. I did not see any of the drain cement tile now in use in this country, and am not, therefore, in a position to make any statement as to their quality or durability.

While concrete sidewalks is one of the earliest uses of

FIG. 17.—REINFORCED CONCRETE ENTRANCE TO SHAFT, WATER WORKS AT BEYREUTH, GERMANY.

cement, its use in both Europe and America for roadways is in a similar state of development. There seems to be a prejudice to the use of concrete for this purpose which operates against the construction of experimental pavements, and this has prevented the attainment of data relative to its adaptability for the purpose. There are, however, some examples of concrete roadways, notably in Vienna, where Leopold Trinka, chief of the Street Department, has been conducting experiments for a number of years. While concrete is used as a base for all street pavements in Vienna, there are, in addition, several streets in which the entire pavement is of concrete. In Fig. 9 is shown the pavement of the Rockgasse near the Börse. This pavement is three years old and in excellent condition, there being only a slight wearing at the joints, none in the gutter and little on the surface. The street is not subject to excessively heavy traffic, but there is, however, sufficiently heavy traffic to test the wearability of the pavement. The concrete roadway in process of construction in Hasner Street (Fig. 10) was also inspected. This pavement is 75 meters (24.61 feet) wide, curb to curb, and has

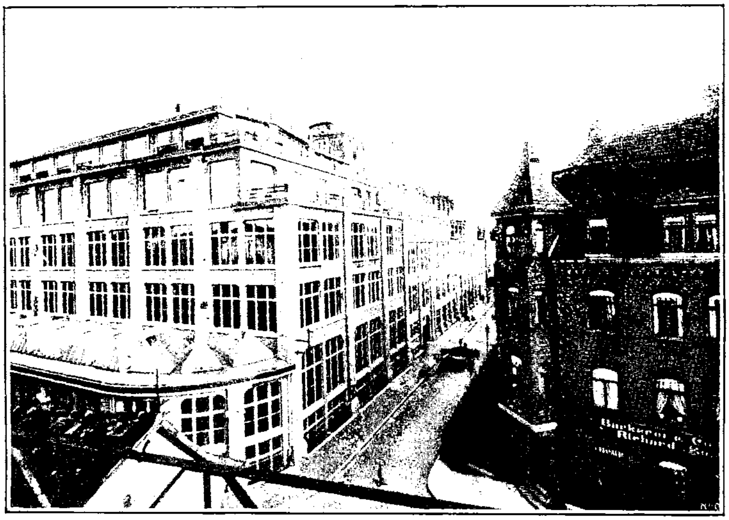

FIG. 18.—REINFORCED CONCRETE FACTORY BUILDING, CARL ZEISS, JENA, GERMANY.

2.5 per cent. crown. It is in two parts, viz. the base is 15 cm. (5.91 inches), and the wearing surface 5 cm. (1.97 inches) thick. The concrete for the base was composed of one part Portland cement to three parts sand to five parts gravel, passing a 4-cm. (1.57-inch) ring, while the wearing surface was composed of one part Portland cement, two parts sand and four parts gravel. The sub-base was carefully prepared by rolling and then thoroughly wetted, and on this the base was laid, the consistency of the concrete being rather wet. The top surface was placed afterward and given a float finish. Joints were made every ten meters, and were formed through the use of tar paper placed in position before the adjacent section was cast. After the wearing surface had hardened somewhat—that is, after the surface water had evaporated—it was covered with sand.

From a conversation with Mr. Trinka, the opinion was formed that he was not in favor of concrete roads where the grades were heavy. His principal objections to concrete roadways was the difficulty of making repairs. As little was known

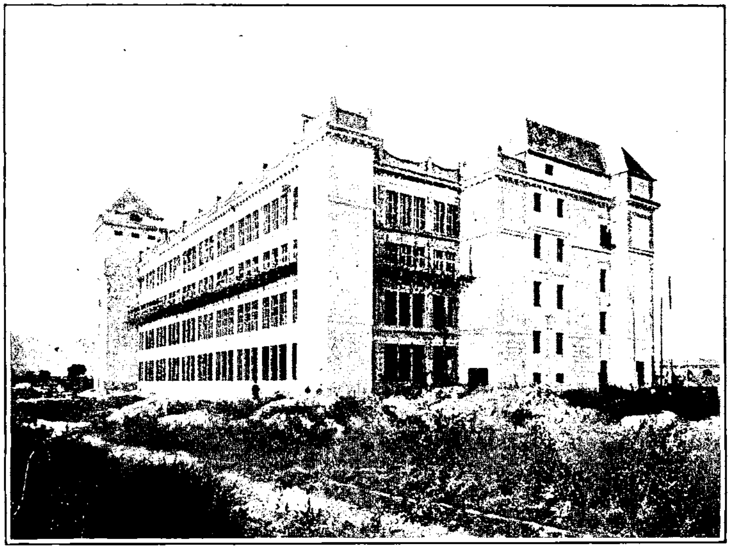

FIG. 19.—REINFORCED CONCRETE MILL BUILDING, POZSONG, HUNGARY.

about concrete roads, and as they were still experimenting with them in Vienna, he was of the opinion that it was impossible to obtain a good concrete roadway without expansion joints, and if the joints were not formed during construction, cracks would develop afterward. He also believed that the thicker the concrete, the more satisfactory would be the roadway.

Many of the cities make use of concrete pavements for alleyways and smaller streets where the traffic is not heavy, and a number of the cities have in contemplation the laying of experimental roadways. After these experiments are completed it will probably be found possible to lay concrete roadways that will answer the requirements and prove more economical as regards first cost and maintenance than many of the forms of pavements now in use.

In Europe, as in America, reinforced concrete, because of its flexible qualities, is considered an admirable material for the construction of filter beds (Fig. 11), and other structures required for water supply and sewage disposal. A number of such works

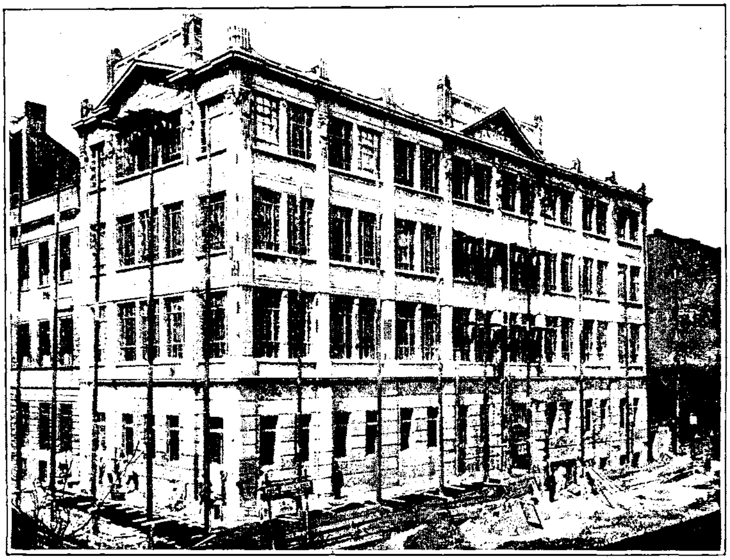

FIG. 20.—REINFORCED CONCRETE FACTORY, PRAGUE, AUSTRIA.

were visited, and mention is particularly made of the controlling works of the sewage-disposal system for the city of Dresden. These are entirely of concrete, and the work was so well done that no patching or touching up was necessary after the removal of the forms, the smoothness of the surface and uniformity of the color being exceptionally good. The concrete was thoroughly mixed, was of a stiff consistency and received considerable tamping. The form work was especially good, and this, together with careful workmanship was responsible for the quality of the work.

In Germany there seems to be a general tendency to use a stiff mixture, and it was stated that this practice was based upon the experiments of Professor Bach, which indicated that the dryer mixtures give the highest results. It is also true that the dryer mixtures do not tend to bring the neat cement to the surface, as is the case with the wetter mixtures, and hence there are less hair cracks.

In reinforced concrete it is, however, difficult to compact stiff concrete around the reinforcement, and the resulting work is

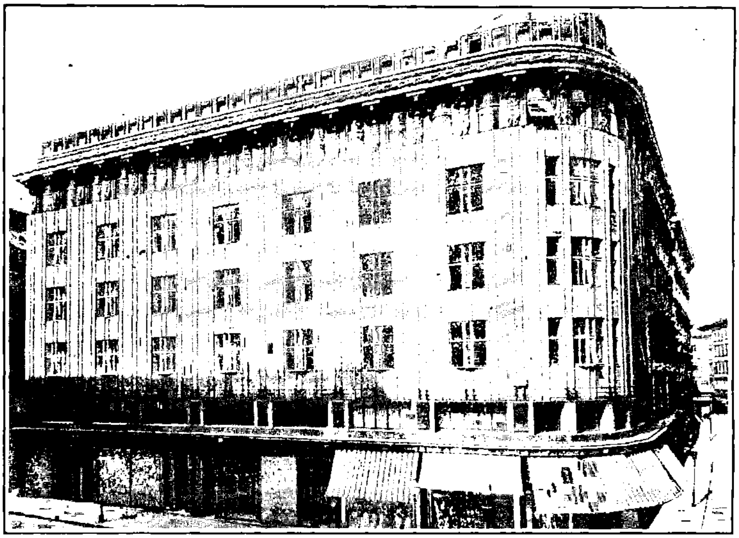

FIG. 21.—REINFORCED CONCRETE HOUSE, VIENNA, AUSTRIA.

unquestionably inferior to that in this country. The stiffness of concrete is, in a measure, offset by the small-sized aggregate used, which facilitates the compacting. I have seen concrete so vigorously tamped in position in a floor panel as to cause vibration of the centering. This floor had a span of about 25 feet, the slab was about 7 inches thick. It is possible that the use of a stiff mortar in plastering, where the surface is thoroughly clean and wetted before it is applied, produces a much more uniform surface, both as regards the texture and the color. It is, however, a fact that the wetter the mixture, the working, which it must necessarily receive, tends to bring the more soluble and softer materials to the surface, and thereby increases the tendency to checking and hair-cracking.

Large and increasing quantities of concrete are being used in railroad construction. This is due almost wholly to the fact that concrete is the most economical material to use. Where materials are more expensive than the labor, more attention is necessarily given to the economy in their use, and, as a result,

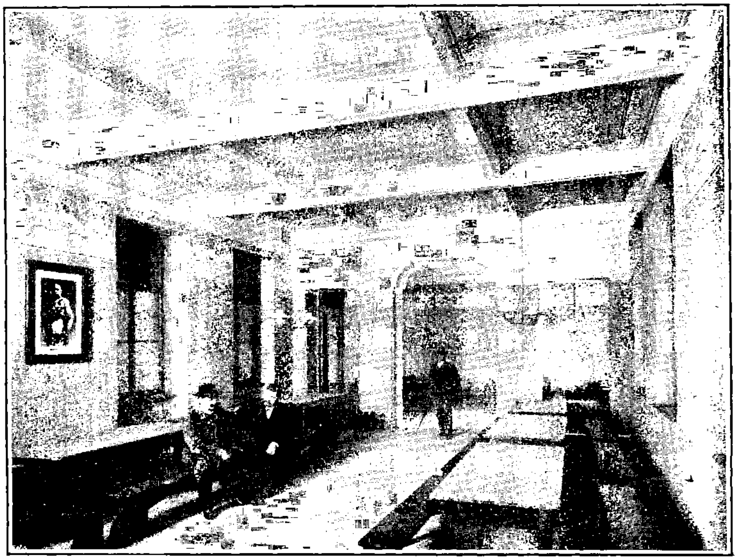

FIG. 22.—DINING ROOM, REINFORCED CONCRETE BUILDING, ASYLUM IN FELDSBERG, AUSTRIA.

forms are more carefully prepared and the concrete more carefully placed. As a result, when the forms are removed little work is required in finishing the structure. The train shed of the Hauptbahnhof, in Nuremburg (Fig. 12), is an illustration of the care taken in the construction of the forms, which results in such perfect structures.

The reinforced concrete trestles (Fig. 13) erected at the municipal gas works, Copenhagen, Denmark, illustrate a tendency toward the use of reinforced concrete as a substitute for steel for this class of work. This practice has been condemned by many prominent engineers in this country, and there are but one or two notable instances, among which may be mentioned the viaduct near Louisville, Ky. There does not, however, appear to be any valid objection to such construction if properly designed in accordance with the laws of mechanics of materials, and concrete serves the purpose just as well as any other structural material and, in addition, has the distinctive advantage of being more durable, economical, and requiring a less cost of maintenance.

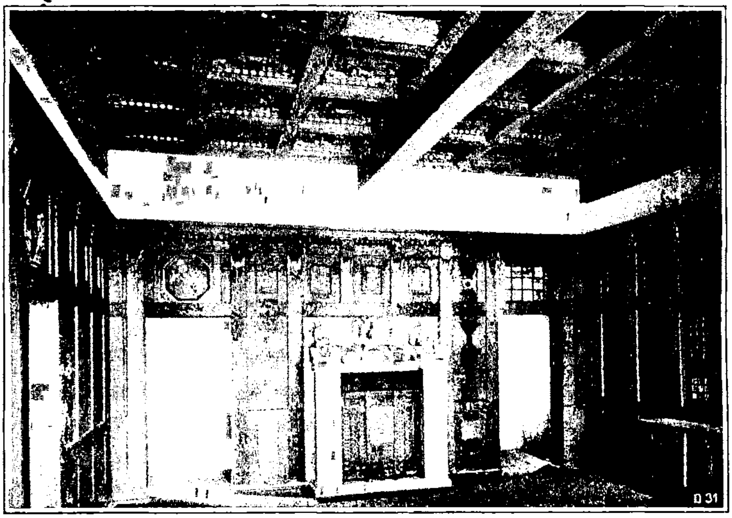

FIG. 23.—REINFORCED CONCRETE HOUSE, DRESDEN, GERMANY.

It is evident that the skill and care of the workmen are responsible in a large degree for the pleasing results obtained in the use of cement for the exterior finish of buildings. Much of this ornamental work lacks the pressed-metal effect which characterizes the appearance of much of the cast-stone work in this country, and this is due to the fact that the surface is gone over with tools, thus removing the skin of neat cement, which gives a dead surface. In addition, the architectural treatment is such as to effectively utilize the natural qualities of the material.

These points are exemplified by the facades shown in Figs.

14 and 15, which have very much the appearance of natural stone. In some instances the ornamentation is placed on the concrete surface after the main structure is finished, but generally it is formed at the time the main structure is cast and is afterwards tooled and dressed by the stone mason, thus removing the marks of construction, the film of neat cement, and giving the structures the appearance of natural stone.

Symmetrical structures in which there has been a well-planned scheme of decoration are quite usual; indeed, one rarely

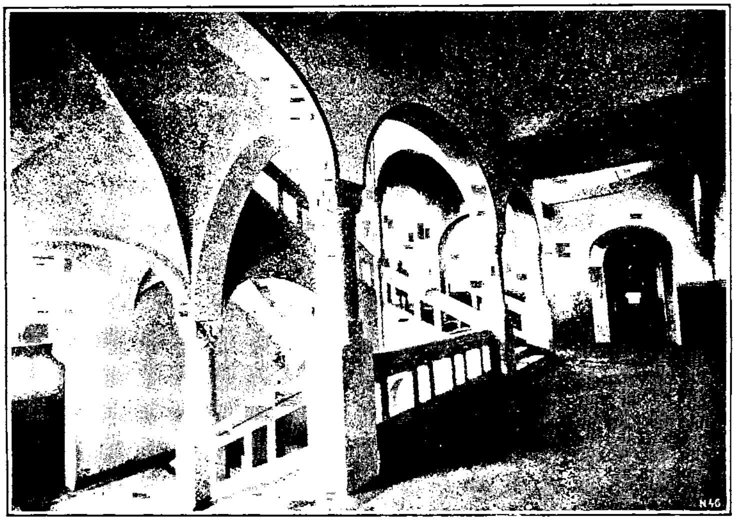

FIG. 24.—REINFORCED CONCRETE STAIRWAY, NORTH SCHOOL, JENA, GERMANY.

sees a structure that does not present a finished appearance. This is a matter in which the American methods may be criticised, especially where the function of the structure is that of utility rather than of ornamentation. Such structures, as a rule, are untouched after the removal of the forms, and, at most, but little work has been put upon them, with the result that they present an unfinished appearance. This condition should not be confused with structures which have purposely unfinished surfaces, as, for example, the grill-room of the Racquet Club in Philadelphia, and the chapel in Mission Inn, Riverside, Cal., in which the rough concrete is a part of the scheme of decoration. It is the unsightly construction marks and stains, devoid of art and, hence, not pleasing to the eye, to which reference is made, and which are almost wholly the result of carelessness in workmanship, avoidable with practically no additional cost.

The facades shown in Fig. 16 serve to illustrate the care given to structures of minor importance in order to secure a pleasing appearance. The clean lines and fine texture are evident, as is also the case of the structure shown in Fig. 17, where the adaptability of concrete is again apparent. A photograph, as a rule, is a very poor medium for conveying an adequate idea of the appearance of a structure, and often gives the impression that the quality is much finer than it really is, since it tends to eliminate the blemishes. On the other hand, it may not do justice to a very excellent structure, and this particularly is the case where the material is concrete. These expressions of opinion are the result of a close inspection of the structures visited, which were singularly free from such blemishes.

The European architects are wonderfully efficient in the use of concrete without veneering. There are many buildings with exteriors wholly of concrete which are as pleasing architecturally as those obtained by the use of any other material. Factory and mill buildings ordinarily admit of little in the way of architectural treatment, but even these are rendered attractive and pleasing to the eye, as may be seen in Figs. 18 and 19, where the paneling and projecting moldings cast shadows, relieving the plain, flat surface. This gives a life to the structure which makes it attractive, and adds little to the cost.

The treatment of the surfaces, after the forms are removed, by plastering or dressing in various ways with stone cutters' tools, produces a surface of uniform texture and gives a finished appearance to the structure.

The small surface molding and relief work shown in Fig. 20, a factory building in Prague, were accomplished with the original forms, and the finishing applied afterward adds very little to the cost. Much more ornamental surface treatment is shown in the dwelling house (Fig. 21), and serves to illustrate the possibilities of the material. This structure presents a much finer appearance than the brick, stone and similar materials which are used so generally.

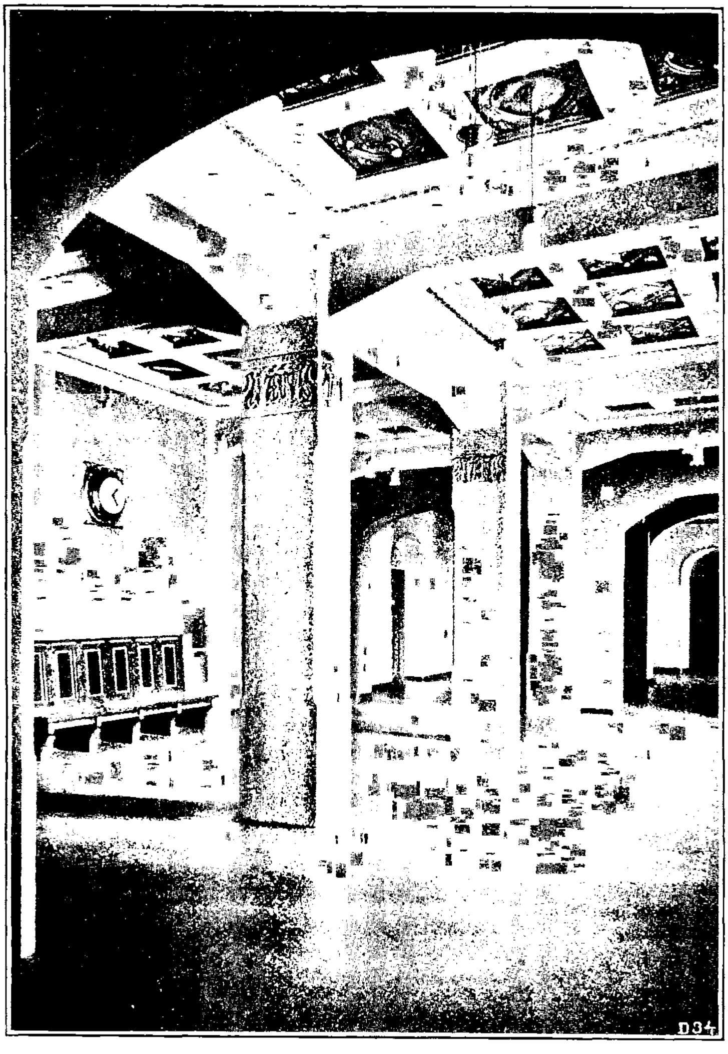

FIG. 25.—REINFORCED CONCRETE BUILDING, KING GEORGE GYMNASIUM, DRESDEN, GERMANY.

There were some sixteen reinforced concrete buildings in the course of construction in the city of Hamburg, Germany, many of which had exterior walls of concrete effectively ornamented through the use of cement. In some of these buildings the work was so well performed that it was difficult to tell whether the walls were of stone or concrete.

The treatment of concrete in the interior of buildings is equally effective. Paneling of the ceiling by means of beams, chamfering the edges, the use of filets and moldings, all tend to improve the appearance of the structure. A successful use is also made of plaster, applied to the concrete, in which various designs are worked out in color. These delicate tints, often applied to walls, are not injured by discoloration, which is frequently seen in this class of work in this country. There are a number of processes used for treating the cement surface by which it is rendered inactive. The main element in the success of this work is the fact that walls are allowed to thoroughly dry out before the final ornamentation is applied. In some countries not only is this required by law, but generally the building cannot be occupied at all until after the lapse of at least several months, and in a few cases until one year, after its completion. These requirements are in striking contrast to the conditions prevalent in this country, where a portion of the building can be occupied while the remainder is still in course of erection. From a sanitary point of view this delay in occupancy is admirable.

The dining-room of one of the asylum buildings in Feldesberg (Fig. 22) serves to illustrate the pleasing treatment of the surfaces of a reinforced concrete building with plaster. Another method of treating such construction is illustrated in Fig. 23, in which resort has been made to a partial veneering with wood, this particular building having been awarded the gold medal of the Dresden Exhibition of 1906. In the view of the stairway of the reinforced concrete school building in Jena (Fig. 24) it is evident that a structure can be simply and effectively treated without involving great expense in the construction of the forms. The balustrade without ornamentation, the groined roof of the stairway, and the simple but effective caps of the supporting columns, form altogether a most pleasing construction. The two views

FIG. 26.—REINFORCED CONCRETE BUILDING, KING GEORGE GYMNASIUM, DRESDEN, GERMANY.

(Figs. 25 and 26) of the interior of the gymnasium in Dresden are also illustrative of the high art attained in the interior treatment of structures of reinforced concrete. The concrete in some portions of this building is left untreated, but for the most part the surface has been plastered, and this plaster tinted in various colors. Although completed for some time, I could find no evidences of discoloration, and the entire made a very lasting impression not only as regards the quality of the coloring, but as

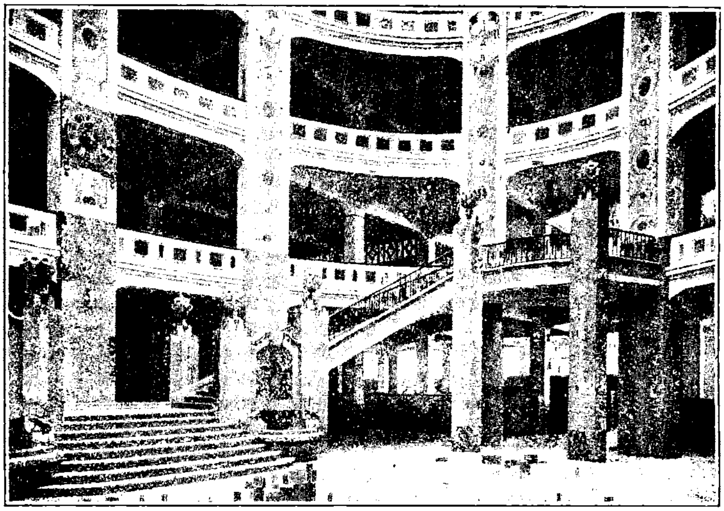

FIG. 27.—CENTRAL ARCADE OF THE REINFORCED CONCRETE BUILDING, THE TIETZ STORES, MUNICH, GERMANY.

regards the details of construction. Attention is directed to the treatment of the columns and paneling of the ceiling, and the extremely simple but effective treatment of the stairway balustrade.

In Paris, I examined a fine structure of reinforced concrete, intended for a music conservatory. In Budapest, Professor Zelinski showed a similar structure designed by himself, which was remarkable for its beauty and the skill exercised in its design. The ornamentation was strikingly good, the acoustic properties were excellent, and the use of the cantilever in the construction of the balcony, thereby eliminating obstructing columns, was a particularly fine piece of construction. The treatment of the surface in the corridors was simple, and the ornamentation consisted in part of designs worked in mosaic.

In many instances the interior finish for concrete buildings was in imitation of the travertine stone obtained from Italy, and was so well done as to make it impossible to tell whether it was artificial or not. Work of this character has been equally well executed in the new Pennsylvania Railroad Station in New York, where, in the lobby of the station, the lower part is of natural

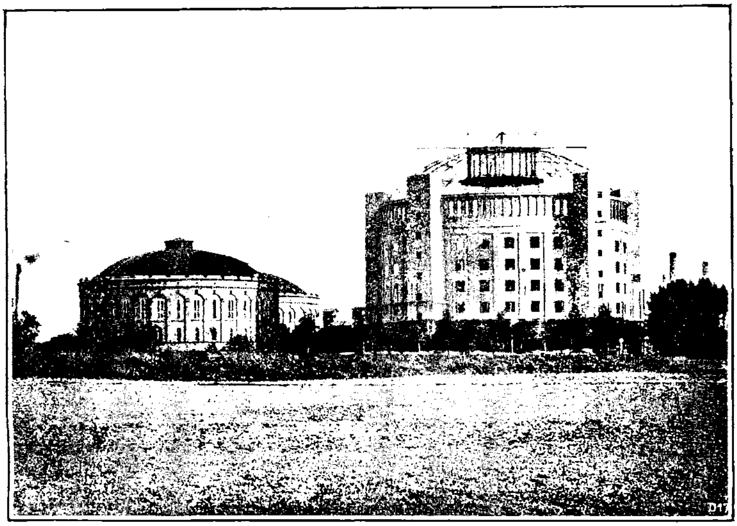

FIG. 28.—REINFORCED CONCRETE WALLS FOR GAS HOLDER, DRESDEN, GERMANY.

travertine stone, while the upper portion is artificial. Even the workmen have difficulty in indicating where the one ends and the other begins.

Light, graceful trusses used for supporting the roofs of buildings are also worthy of notice, and ample evidence is afforded of their stiffness in the attached shafting and other machinery, which produces no appreciable vibration to the structure.

Perhaps one of the most pleasing examples of the decorative art was the treatment of the central arcade of the reinforced concrete building (Fig. 27) of the Tietz stores, in Munich; the paneling of the ceilings, the detailed construction of the columns and the ornamental work being so apparent that further description is unnecessary.

The spirit of ornamentation is illustrated in the gas holders of the city of Dresden, shown in Fig. 28. In this country,

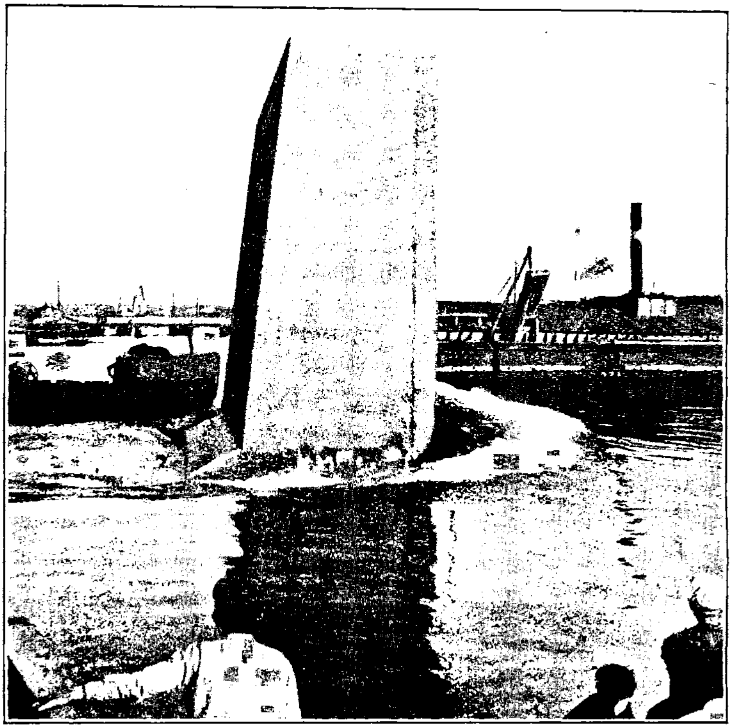

FIG. 29.—REINFORCED CONCRETE FOUNDATION FOR QUAY WALLS IN HARBOR, NORRESUNDBY, DENMARK.

especially, these are unsightly structures of metal. In this case the walls, of reinforced concrete made to imitate granite, serve as a container for the holder proper, which is of metal. The surfaces of these walls are hammer-dressed, and the metal-covered roof, supported by steel trusses, is painted with a green-tinted paint, giving the appearance of oxidized copper, the whole structure being unusually attractive and pleasing, which is not usual

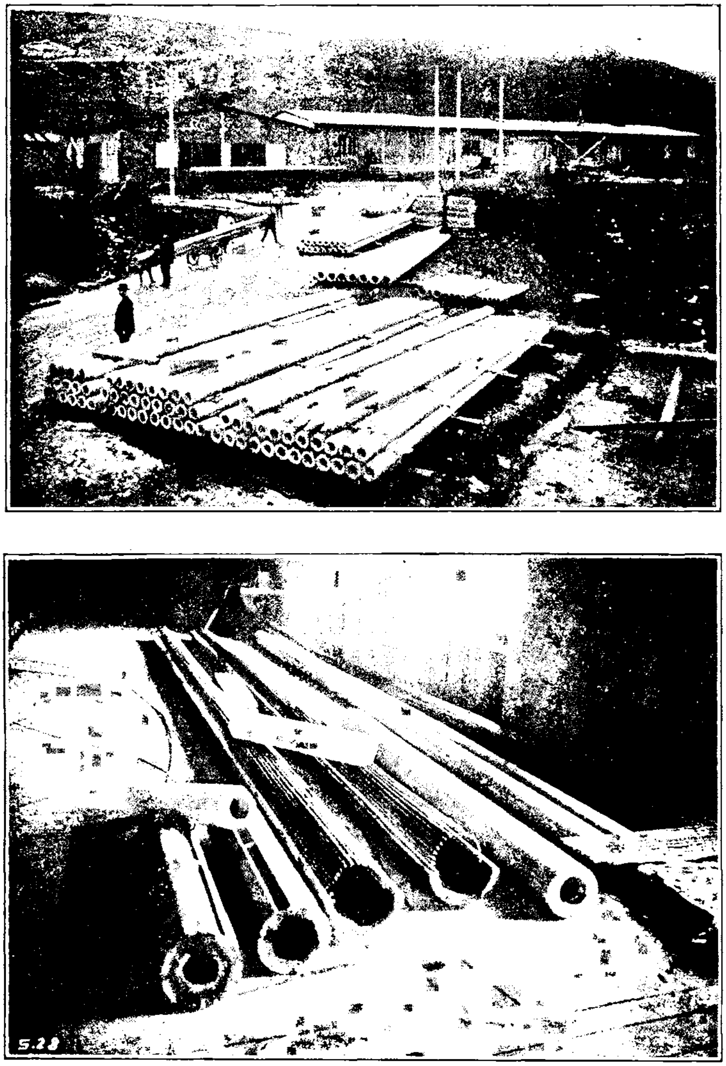

FIG. 30.—HOLLOW REINFORCED POLES, OTTO AND SCHLOSSER S PLANT, MEISSEN, GERMANY.

in a structure of this character. The view given shows one of the roofs of the holder uncompleted and serves to illustrate the character of the roof construction, the steel work not being incased in concrete. The towers seen contain stairways, also of reinforced concrete. The gray tone of the walls is in splendid contrast with the soft green coloring of the roof.

In the design of reinforced concrete structures, the European engineer seems to have a better appreciation of the laws of design, which shows itself not only in the gracefulness of the structure, but also in the thickness of the concrete itself. A number of concrete water towers were visited, with walls extremely thin, and reference is made to one in Budapest, designed by Professor Zelinski, which was perfectly tight, although there was a considerable head of water. The thin walls had been rendered tight not by waterproofing, but through the intelligent use of metal reinforcement, a practice which is at last beginning to be understood and applied in this country.

In the use of reinforcement for harbor work there was much of interest. The length and manner of driving the concrete piles in the harbor work at Boulogne-sur-Mer was particularly impressive. The piles apparently stood the severe hammering of the pile-drivers without damage. Results similar to this have been achieved in driving the piles in connection with the harbor work at Chester, Pa.

An application of reinforced concrete that is likely to come into greater use is illustrated in Fig. 29. The boxes of reinforced concrete are constructed on shore, launched as shown, towed to a point where they are settled into position by filling with sand, gravel or crushed stone; upon this superstructure the quay wall is then built. This method of construction permits the thorough hardening of the concrete before it is subjected to the action of sea water.

Reinforced concrete telephone and telegraph poles seem to be coming into general use, especially in Holland, Sweden and Denmark, in which countries inspection was made of poles that had been in use for some time. Some types of poles are shown in Figs. 30 and 31, the feature of which is the attempt to lighten them, and thereby save material, through the means of holes spaced regularly as shown. Nearly all of the poles examined were in excellent condition and seemed to answer the purpose admirably. The strength and permanency of this type of pole

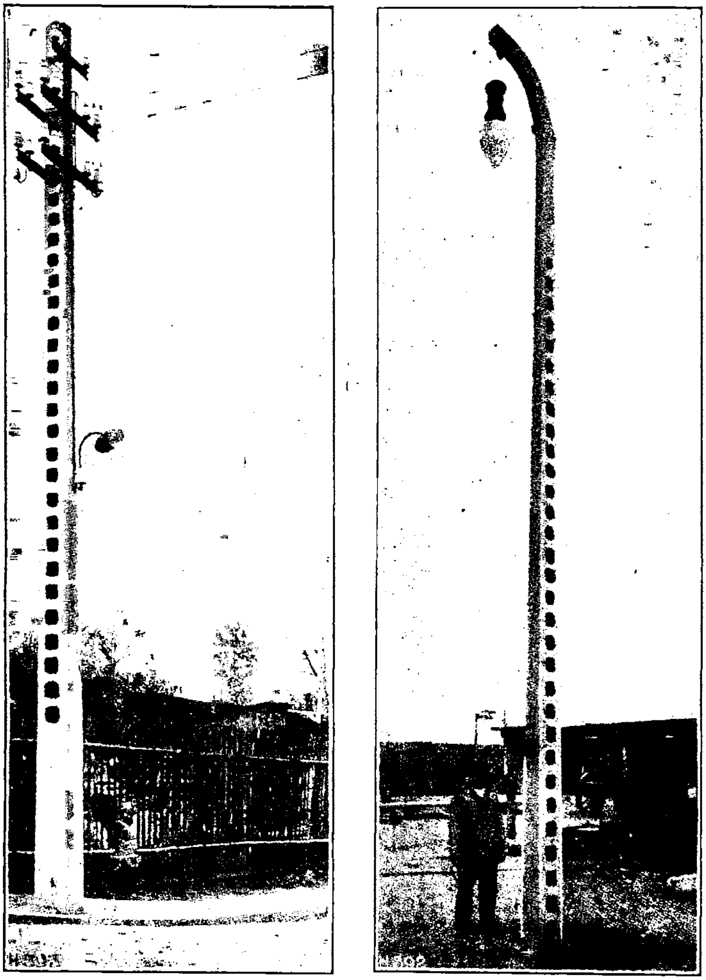

FIG. 31.—REINFORCED CONCRETE LIGHT, TELEPHONE AND TELEGRAPH POLES.

make it preferable to poles of wood or steel, even where the first cost may be somewhat greater.

An interesting use of concrete is the rustic foot bridge shown in Fig. 32, the entire structure being of concrete with a small amount of metal reinforcement. The floor and railing were cast, using the planks and railing of the previous structure in forming the molds.

Equally interesting is the reinforced concrete fence shown in Fig. 33. The hinges were imbedded in concrete. While these gates are quite heavy and are frequently closed with such vigor as to jar

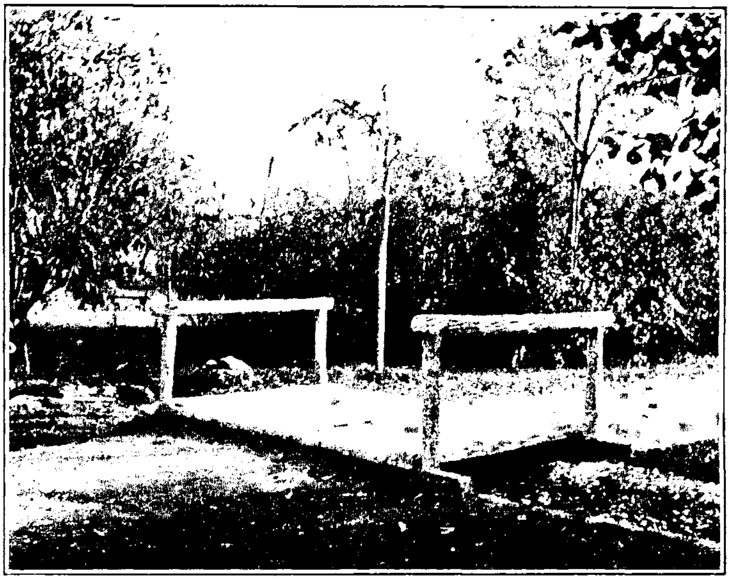

FIG. 32.—FOOT BRIDGE IN PARK, ENTIRELY OF REINFORCED CONCRETE, BUDAPEST, HUNGARY.

the fence, the cracking is not nearly as bad as might be expected. This, however, is a use of concrete for which it is not suited, because of the weight and the consequent shock on the hinges in opening and closing the gates. The fence itself was in excellent condition, and demonstrated the adaptability of concrete for the purpose.

Mention should also be made of the reinforced concrete boat, or barge, inspected at Frankfort-on-the-Main, 42 meters (138 feet) long and 6.5 meters (21.32 feet) wide at the center, and with walls 4 cm. (1.48 inches) thick. The boat was being repaired at the time because of the unequal distribution of the concrete, due to faulty design, which had caused a serious list. The boat was painted with asphalt and seemed perfectly watertight. It contained a small cabin in the stern, the remainder of the boat being intended for cargo. The same constructors contemplated building another boat 70 meters (229.66 feet) long. Boats of this character are being constructed and successfully used in this country, especially in connection with the construction of the Panama Canal. The success of these boats depends

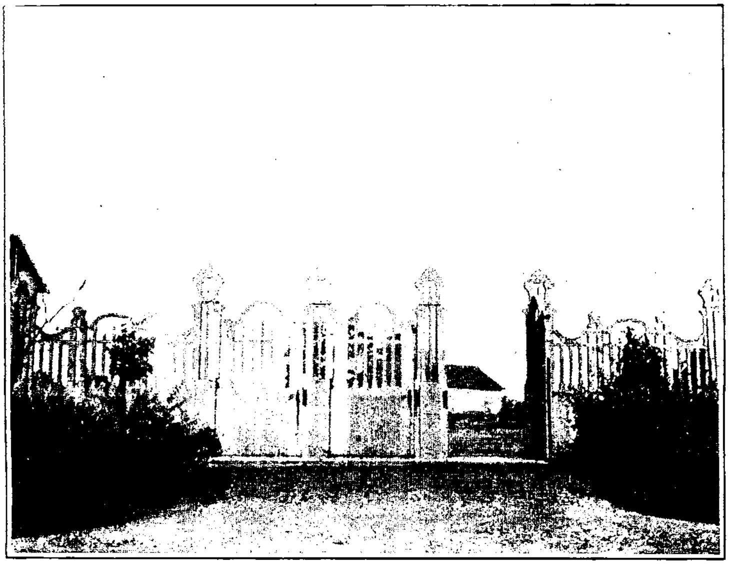

FIG. 33.—REINFORCED CONCRETE FENCE, BUDAPEST, HUNGARY.

largely on the design, which, if proper, should make them sufficiently stiff and thoroughly watertight. When well designed and built, the first cost is little, if any, greater than when built of wood, while the cost of maintenance is very low and the durability very great. In view of the growing scarcity of timber, it is probable that this type of boat will meet with increasing favor.

In Europe, as in America, concrete is winning its way as a building material because of its intrinsic qualities, which make it superior as regards strength, durability and fire-resistive qualities, and also the most economical.

Many of the problems that are at present receiving consideration in this country are also under consideration in Europe. The investigations of the properties of concrete have been more extensive than those in this country, and the results contain much data of value to the American engineer. Too little reference has been made to the work of the foreign investigator when reporting the results of the investigations in this country.

While reinforced concrete construction had its origin in Europe, and has been in use, therefore, longer than in this country, yet it is surprising that the present extent of this use is no greater. One cause that operates against the development of its use in buildings lies in the restrictive, and in many cases prohibitive, building regulations, which render it impractical either to use the material in the larger cities at all, or with any economy. Hence, its use is almost wholly outside of these cities. The revision of these laws is under consideration in most foreign cities, the purpose of which is to so modify them as to render this class of construction possible. The economic value of the material, coupled with its superior qualities from a sanitary and fire-resistive point of view, is aiding materially in the fight for its proper recognition.

In general, it may be stated that America leads not only in the extent, but also in the diverse uses of concrete and reinforced concrete. It is, however, in the artistic use that Europe excels; the results obtained are in general much more pleasing. When American architects become more familiar with, and confident in the use of, concrete, treating it as a plastic material with an individuality of its own, and not as a substitute for other and, in most cases, inferior materials of construction, we can hope to rival Europe in this field. Many foreign designers also appreciate its properties and possibilities more fully than is the case in America, and more economically designed structures are the result.

Europe is watching America's progress with keen interest, and with good reason, for already we have designed structures of concrete in which full use has been made of its admirable qualities. We are also formulating rules for its use that are being accepted in other countries, and our knowledge of design is so progressing that economical structures are becoming more common. In the very near future we may look to see America lead the world in the artistic and economical use of concrete.

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SOME FALLACIES IN METHODS OF FIREPROOFING.

Annual Address by the President,

Richard L. Humphrey.*

The story told by the great conflagrations that have swept some of the large cities of this country cannot be too often repeated because it is a lesson more effective than all lectures or warnings that can be given. It is a matter of wonder to most of those interested in fire losses as to how long the people of the United States will continue to remain indifferent to these enormous annual losses. These great conflagrations have appalled the people for brief periods, but have not been sufficient to secure the adoption of effective and efficient laws which would forever prevent their recurrence. The San Francisco conflagration in a period of three days produced losses that wiped out the profits of twenty years in the insurance business. It was recently stated by one of the prominent insurance men of this country that if a fire should destroy the City of New York south of Fourteenth street, it would bankrupt every insurance company in the country.

While the public is momentarily aroused by these great confla-

*Consulting Engineer, Philadelphia, Pa.

grations, in the absence of a well defined policy it is difficult to utilize this aroused public sentiment to secure the enactment of efficient laws. It is necessary first, that those who prepare them shall be sufficiently familiar with the requirements that there may be enacted laws which will really prove effective. The contrast between the policy pursued by the European countries and that of this country is glaring. In Europe the practice is to study the means of preventing fire and maintain a sufficient fire brigade for the purpose of putting out fires in the contents of a building. In

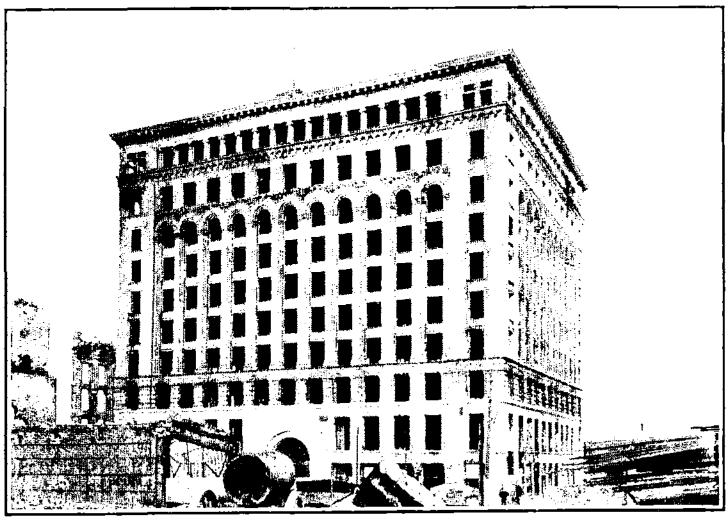

FIG. 1.—MILLS BUILDING, SAN FRANCISCO, AFTER FIRE.

this country, our lax building laws permit the erection of almost any type of structure and the public treasury is largely devoted to the maintenance of expensive fire fighting brigades. In the one case large sums of money are expended in securing the best fire resistive buildings possible, in the other case the money is expended in providing apparatus for putting out fires in non-fire-resistive buildings. So proud are we of our splendid and efficient fire brigades and methods of fighting fires that we are prone to drift into the comfortable feeling that our fire service is all that is necessary to afford a proper protection.

Under ordinary circumstances, such service would doubtless prove efficient, but one has but to recall the Baltimore fire where bitter winter weather so seriously crippled the water supply as to render fire fighting a rather primitive process. In the San Francisco fire, the crippling of the water mains by the earthquake

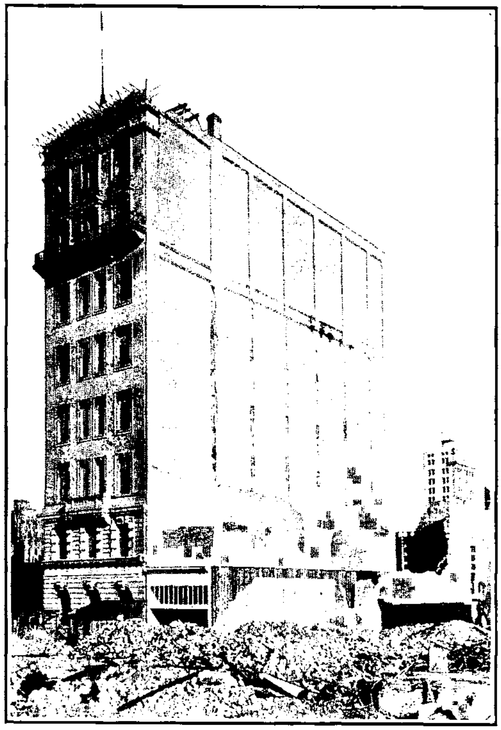

FIG. 2.—PACIFIC STATES TELEPHONE AND TELEGRAPH BUILDING, SAN FRANCISCO, AFTER FIRE.

rendered practically useless the fire fighting service: the little work done was by means of long lengths of fire hose taking water from San Francisco Bay. It has been frequently stated that some day the City of New York will have a conflagration which will destroy so much property as to paralyze business and possibly induce a panic. This statement is always ridiculed by the champions of the fire brigade, and yet it frequently happens that fires under difficult conditions in winter are not controlled as quickly as they should be; as an instance of this, the Parker Building stands as a monument of the extent even the finest fire fighting equipment may be rendered useless through the failure of the water supply. It should not be considered for a moment that a proper fire fighting service is unnecessary, on the contrary, with adequate building laws which insure structures reasonably fire resisting, it is absolutely essential that there shall be maintained a service which can

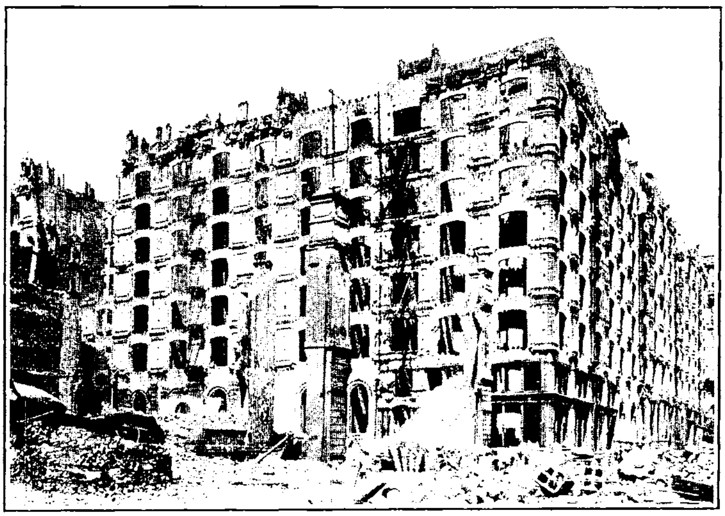

FIG. 3.—PALACE HOTEL, SAN FRANCISCO, AFTER FIRE.

quickly extinguish any fire which might occur in the contents of such buildings. It will probably be a matter of great difficulty to make adequate laws retroactive, and we must wait for the gradual substitution of fire resistive types of buildings for many of the inflammable fire traps that are a menace to our large cities at the present time. While it may be debatable as to whether or not these laws should be retroactive in all parts of the city, it certainly is a fact that within the fire limits of our great cities no structure should be permitted which did not fulfill the requirements of a reasonably fire-resistive building regardless of its occupancy.

The unusual low per capita losses of Europe in contrast with the enormous losses of this country furnish a story which we are prone to use on all occasions for the purpose of pointing out the

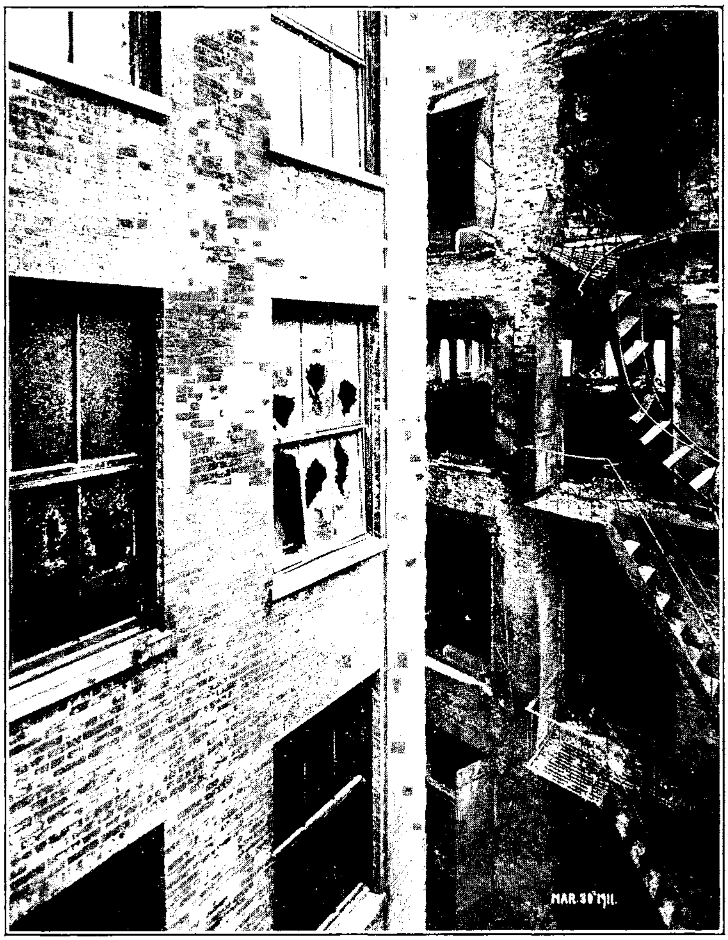

FIG. 4.—FIREPROOF BUILDING ADJACENT TO ASCH BUILDING, NEW YORK, SHOWING PROTECTION AFFORDED BY WIRE GLASS IN METAL FRAMES.

superiority of European methods compared with those in this country. Laws of all kinds are necessarily a matter of evolution and it becomes necessary to increase their strictness with the increase in density of population, so that while it might be permissible to erect structures of wood in a small town, such structures should not be permitted in a large city, because of their menace to surrounding property. Our building laws are gradually becoming more and more strict, and we are gradually acquiring better fire-resistive types of buildings. It should be remembered that in many of the foreign countries there is an abundance of stone and slate in

FIG. 5.—WELLS-FARGO BUILDING, SAN FRANCISCO, SHOWING EFFECT OF FIRE.

contrast to the abundance of timber in this country, and this has resulted in even dwelling houses being constructed of stone walls and slate roofs, and thereby producing a building of high fire resistance.

It would seem apparent in developing a better condition as regards the danger from fire in this country, that one of the first things is to establish the comparative value of the various materials that are used for fireproofing purposes, and to test out the various methods in use. Unfortunately, most of the data

FIG. 6.—VOLKMAN BUILDING, SHOWING PROTECTION AFFORDED BY FIREPROOF DOORS AND WINDOWS.

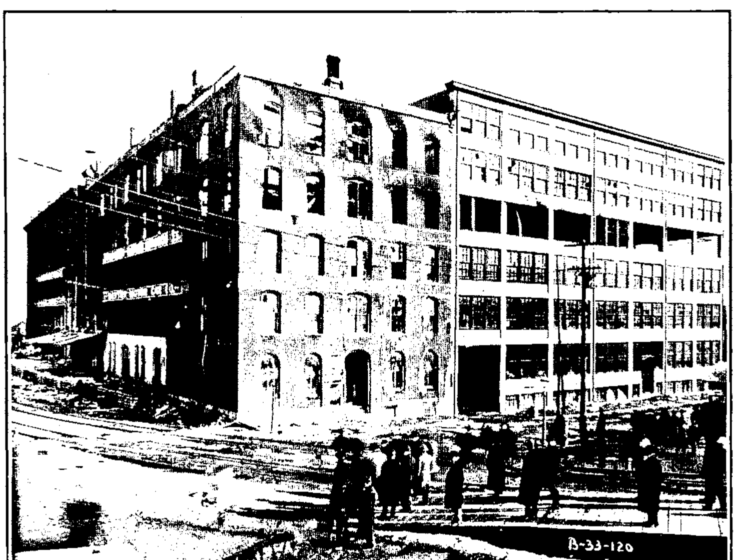

FIG. 7.—REINFORCED CONCRETE BUILDING OF DAYTON MOTOR CAR COMPANY, WITH ADJOINING NON-FIREPROOF BUILDING DESTROYED BY FIRE.

available resulted from great conflagrations, as we have not the means of making as careful and accurate comparisons as might be possible under more controllable conditions. Even when defects are found in materials of supposedly high fire-resistive properties, it requires a great deal to correct the previous false impressions.

The object of this paper is to point out a few fallacies in the commonly employed methods of fireproofing in this country.

A study of the San Francisco conflagration reveals the fact that there were large unbroken areas of frame buildings which easily succumbed to the flames. Occasionally a building of a fire-resisting type would form at least a partial barrier or check to the sweep of the flames. A building must not only be fire-resistive, as regards its contents, but also to fires in adjoining buildings. In order to prevent the spread of the fire, dynamiting was resorted to in San Francisco; this might have proved effective if water had been available to so dampen the destroyed buildings as to render them unburnable, but in the absence of water through the failure of the water supply, the ruins accelerated, rather than retarded, the fire.

A building, however, with properly protected openings, not only checks the fire, but retards it, in that there is no fuel added to the flames. A building well designed, with properly protected openings and non-burnable walls and roof, becomes a barrier to external flames and serves as an additional barrier to the adjoining buildings in that it is possible to confine the fire within the building itself, and when the interior of the building is properly broken up with fire walls, it is possible to confine the fire to the point of origin. Many buildings are destroyed by exterior fires which gain access through insufficiently protected doors and windows.

A casual examination of the exterior of the Mills Building, San Francisco, Fig. 1, would lead one to believe that it had satisfactorily passed the conflagration. A more careful examination will show, however, as is the case with many of the other buildings of this character, that the windows, doors, ornamental trim, and a large percentage of the fireproofing were completely destroyed, and a number of the columns buckled. The salvage in this building was less than 25 per cent., which leads to the natural query, has the building successfully withstood the fire?

The Pacific States Telephone and Telegraph Building, Fig. 2, differs from the preceding structure in that it was provided with protected windows and doors and, therefore, suffered little damage, although surrounded by a fire which was probably hotter than that which destroyed the Mills Building. Unfortunately, there was a weakness in this building, an imperfect barrier in the rear doorway, through which the fire gained access and did some damage.

The famous Palace Hotel, Fig. 3, was a wooden joist building, only the brick walls of which survived, because of their substantial construction. It is sometimes pointed out that brick is an admirable fireproof material for buildings, but we must bear in mind that we cannot build beams or floors with brick, and that it can only be used for piers and walls, and while this material passed the fire admirably, in the case of the Palace Hotel, the value of the remaining brick walls was but a small percentage of the entire cost of the building. The reason bricks are so much better in their fire resistance than other clay products is that while they expand under heat quite as much as other building materials of clay, they are of small size and the relatively larger number of joints enables the expansion to take place without visible damage to the structure.

Fig. 4 shows the building adjoining the Asch Building, New York, in which the metal frame wire glass windows served as an effective barrier against this fire. The holes in the wire glass were punched by the firemen, who used these windows as shields in fighting the fire in the Asch Building. This clearly shows if a building is to be properly protected by fireproof windows, these windows must be of the proper type. The view given in Fig. 5 shows the court of the Wells-Fargo Building, in which ordinary glass was used in metal frames, the melting and failure of the glass destroyed whatever merit there may have been in the frames themselves, and the barrier was little better than an ordinary wood frame window.

Fig. 6 shows the exterior of the Volkman Building, where may be seen fireproof doors and windows of the approved type, which not only resisted the fire from without, but also successfully withstood the blows of the falling walls of the adjoining building.

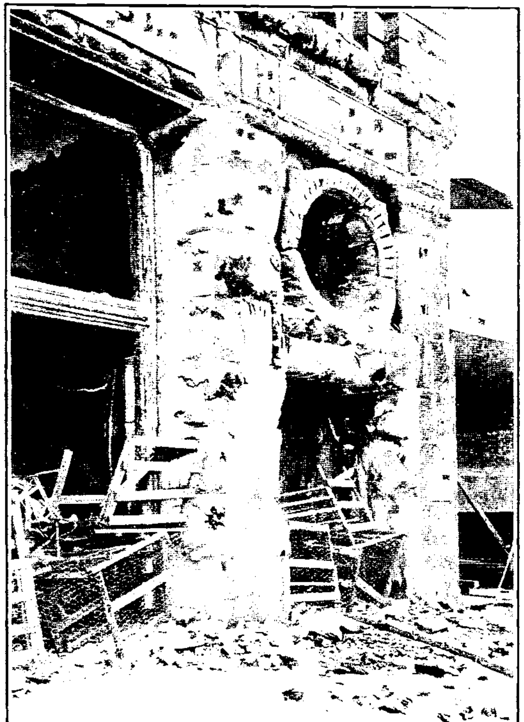

FIG. 8.—ORNAMENTAL STONE WORK DAMAGED BY FIRE, ENTRANCE TO ÆTNA BUILDING, SAN FRANCISCO.

FIG. 9.—GRANITE COLUMNS DESTROYED BY FIRE, HOBART BUILDING, SAN FRANCISCO.

FIG. 10.—INTERIOR STONE COLUMN, CITY HALL, SAN FRANCISCO.

FIG. 11.—FAILURE OF CAST IRON COLUMN, LOAD CARRIED BY CONCRETE FILLING, ACADEMY OF SCIENCES BUILDING, SAN FRANCISCO.

FIG. 12.—FAILURE OF CAST IRON COLUMNS, CAUSING COLLAPSE OF CINDER CONCRETE FLOOR.

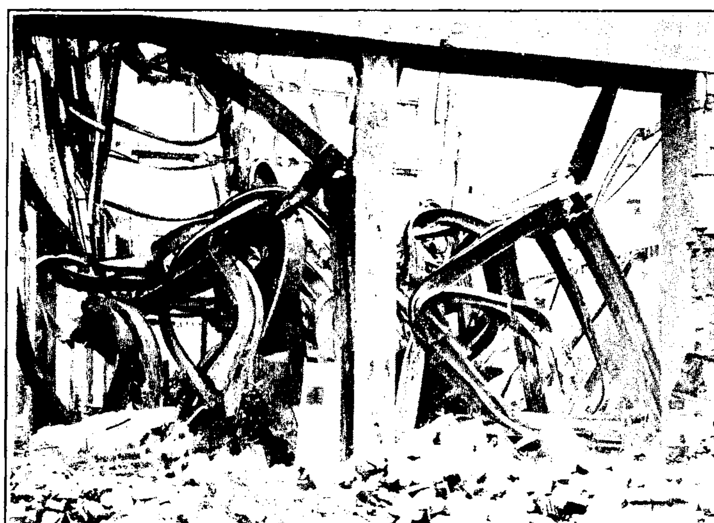

FIG. 13.—RESULT OF FIRE IN BUILDING WITH UNPROTECTED STEEL STRUCTURAL MEMBERS.

How effective barriers of this kind may be in preventing the spread of the flames is illustrated in Fig. 7, of the Dayton Motor Car Company, where it will be seen that a fire on one of the floors of the reinforced concrete building did not spread to the adjoining floors, but did spread to and completely destroyed the adjacent non-fireproof building. It is interesting to note that the cost of the repairs to the reinforced concrete building after this fire was comparatively small, while the adjoining building suffered practically a total loss.

In taking up the various phases of fire-resistive types of buildings, we should bear in mind that the trim or ornamental parts of the structure constitute a very high percentage of the total cost, and it is, therefore, desirable to use in the buildings material which will suffer the least damage from fire. The preliminary investigations of the fire-resistive properties of building materials which were conducted by the United States Geological Survey at the Underwriters' Laboratories in Chicago, showed that even our natural building stones require investigation in order to develop the best manner of quarrying for maximum fire resistance. It was found that it made considerable difference how the stone was quarried, and that a fairly high resistance might be obtained by quarrying the stone in the proper way. Many stones, such as granite, spall badly under the action of the flames.

The view of the Ætna Building entrance, Fig. 8, shows how badly the ornamental stone work was damaged by the flames. In fact, most of it was so seriously damaged as to destroy its value. Where natural stone is used as a structural column, the damage by flames becomes much more serious, as illustrated in Fig. 9, which shows two granite columns in the Hobart Building, San Francisco, that were so badly spalled by the fire as to necessitate wooden props being placed in order to prevent the structure from collapsing. Fig. 10 is an interior column of the City Hall, whose strength, as may be readily seen, was reduced more than 50 per cent. through the action of the flames. It is quite evident then that an unprotected stone column is an extremely poor structural member, the destruction occurring from rapid expansion under heat, although the stone itself is unburnable. There is as much reason, therefore, for protecting a stone column as there is to protect a steel or a concrete column or any other structural member.

The writer understands that the cast iron columns supplied for the Academy of Sciences Building, San Francisco, Fig. 11, were too light, and in order to stiffen them sufficiently to carry the proposed loads, the interior was filled with concrete. The fire

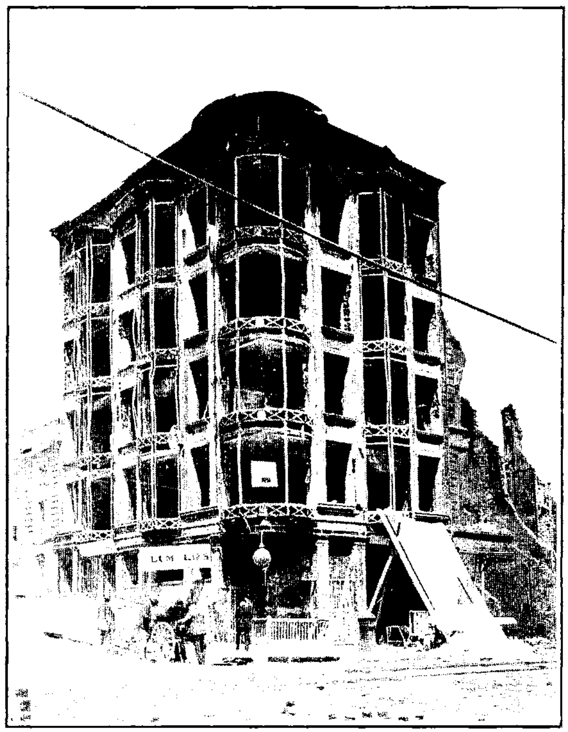

FIG. 14.—EFFECT OF FIRE ON BUILDING WITH NON-FIREPROOF EXTERIOR.

which destroyed the portion of the building supported by these columns, expanded the unprotected iron and caused it to crack, as shown, but the concrete remained uninjured and continued to carry the load.

Fig. 12 illustrates how the failure of the one member of a structure may cause a failure of the surrounding parts, and lead to a false conclusion as to the cause of the failure. In this case, the failure was ascribed by some to the failure of the cinder concrete floor, and not to the cast iron columns. As a matter of fact, the failure of the cast iron columns in the fire withdrew the support to the cinder concrete floor and caused its collapse.

A common fallacy is the belief that because a building is constructed with walls of brick or stone, with columns, girders and

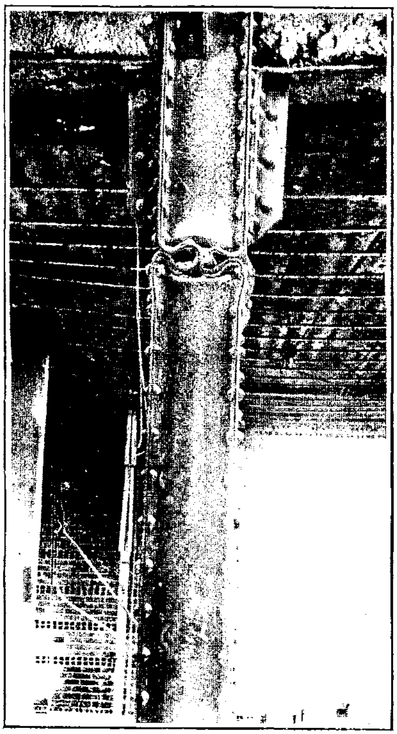

FIG. 15.—FAILURE OF COLUMNS INCASED IN METAL FABRIC COVERED WITH HARD PLASTER, FAIRMOUNT HOTEL, SAN FRANCISCO.

FIG. 16.—BUCKLED COLUMN, HOTEL HAMILTON, SAN FRANCISCO.

beams of steel and with a floor of concrete, that the building is fireproof. One has only to look at Fig. 13 to see how foolish this supposition is. Here the total collapse of the unprotected steel work of such a building stands as a monument to bad construction, and of the fallacy of calling such a structure fireproof.

FIG. 17.—FAILURE OF COLUMN PROTECTED BY SINGLE LAYER OF WOVEN WIRE COVERED WITH HARD PLASTER.

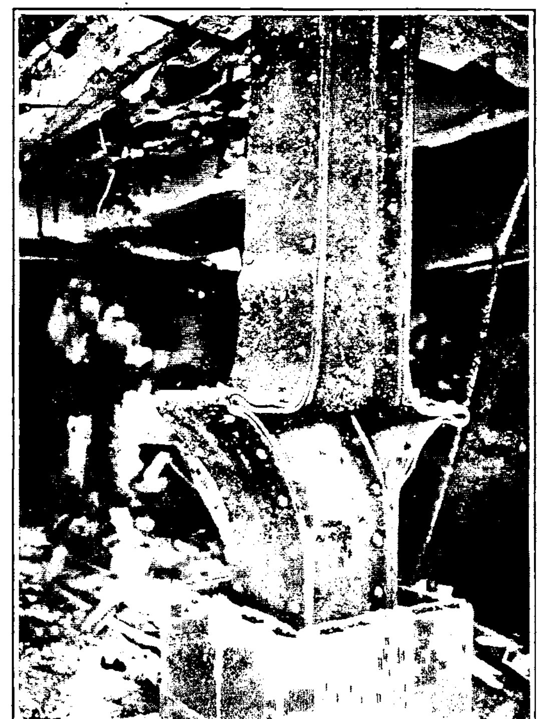

FIG. 18.—FAILURE OF STEEL COLUMN, FIREPROOFED WITH TERRA COTTA.

It often happens that the floors and columns of a building are properly constructed for reasonable fire resistance, but the building is provided with flimsy walls and window openings, through which the fire gains access to and destroys the contents. While it is true that the floors and columns are still standing in the building shown in Fig. 14, the entire exterior is so damaged that the value of what remains forms but a small part of the original cost of the building.

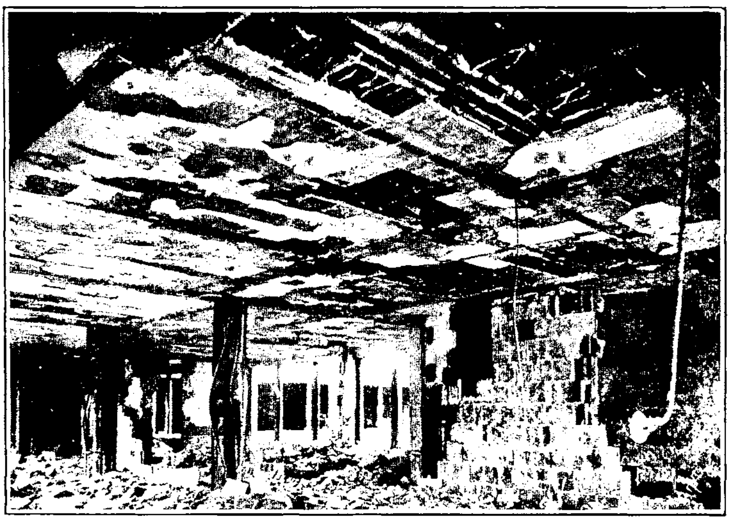

FIG. 19.—FAILURE OF STEEL COLUMN FIREPROOFED WITH TERRA COTTA, DUE TO BUCKLING OF ENCLOSED PIPES FROM EXPANSION.

There is perhaps no greater fallacy than in the matter of fireproofing steel columns. Fireproofing of the flimsiest character is placed in buildings where a large number of people congregate and, after all the decorations and trim of the building are in place, the occupants enjoy a false sense of security, in the belief that the building is fireproof. A notable example of an inefficient method of fireproofing is afforded by the Fairmount Hotel, San Francisco, where more than one hundred steel columns buckled under the heat produced by the small amount of combustible material which was found on the various floors of this uncompleted building. This fireproofing consisted in bending the metal fabric forming the partition walls, around the columns and giving it a coat of plaster. In other words, the entire protection afforded the column consisted in perhaps ¾ in. of hard plaster. This protection proved entirely inadequate, and the columns failed in the manner illustrated by Fig. 15.

FIG. 20.—FAILURE OF STEEL COLUMN THROUGH EXPANSION OF ENCLOSED PIPES DESTROYING THE TERRA COTTA FIREPROOFING.

The view, Fig. 16, shows a buckled column in the Hotel Hamilton, San Francisco, which was protected in this manner, and it will be observed that the metal fabric, which has been removed so as to show the buckling in the column, also serves to show how flimsy this method of fire protection actually is.

In Fig. 17 may be observed a column protected with ordinary woven wire, covered by a single layer of hard plaster. In this case there were imbedded the various pipes and electric conduits, and the buckling of these resulted in the stripping of the plaster from the column, and this undoubtedly was followed by the buckling of the column.

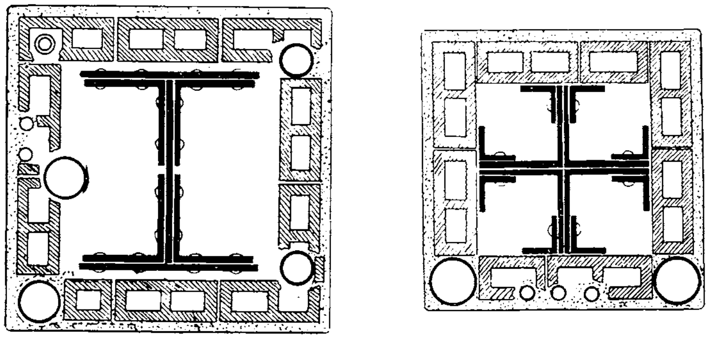

FIG. 21.—SECTION OF COLUMN FIREPROOFED WITH TERRA COTTA ENCLOSING PIPES.

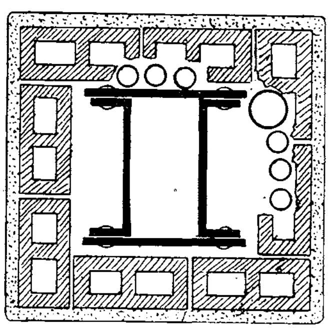

FIG. 22.—STEEL COLUMN FIREPROOFED WITH TERRA COTTA, WHOSE INNER WEBS ARE IN SOME CASES ENTIRELY CUT AWAY.

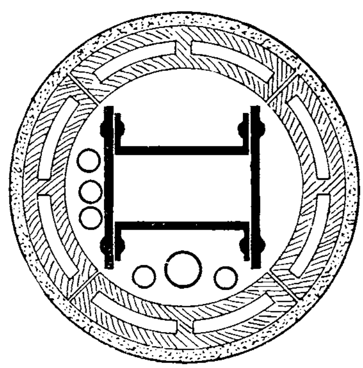

FIG. 23.—CIRCULAR TERRA COTTA FIREPROOFING OF STEEL COLUMN. EXPANSION OF PIPES WILL DESTROY FIREPROOFING.

One of the common materials for fireproofing columns is terra cotta tile. This material is in itself non-burnable, and for this reason there is a prevalent fallacious idea that the material is a fireproofing material of the first class. The tile, as commercially manufactured, has usually webs 5/8 in. thick. Many of these tiles are cracked in the process of manufacture, and thereby weakened. When the tiles are laid up as a fire protection to a column, girder, beam or floor, the expansion of the exposed web or face of the tile being much more rapid than that of the inner webs, failure results from the cracking and falling off of the web, be-

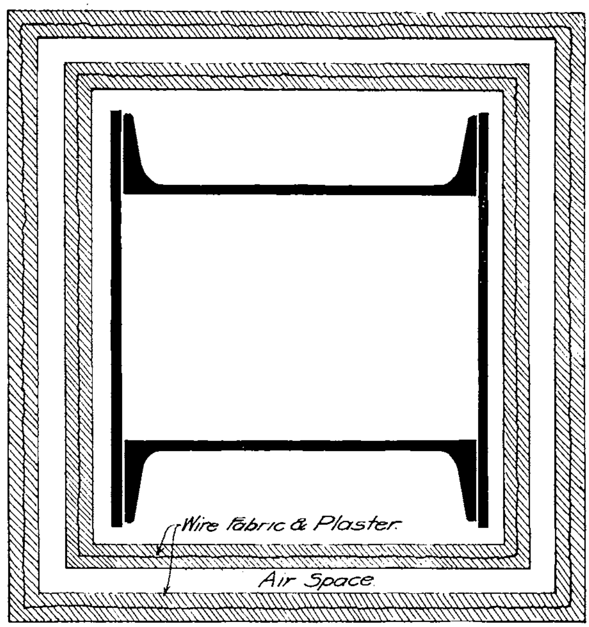

FIG. 24.—STEEL COLUMN FIREPROOFED WITH DOUBLE PLASTER ENCLOSURE LEAVING AIR SPACE.

cause of its insufficient strength to resist this expansion, which leaves the unprotected member to the mercy of the flames. Fig. 18 is a view of column in a building "fireproofed" with terra cotta tile, which has failed by buckling, as a result of the failure of this "fireproofing" from expansion under heat.

It too frequently happens that the architect, in order to secure a presentable appearance for his columns, places metal pipes and conduits of various kinds around the structural member. The expansion of these pipes from heat causes a stripping of the fire protection of the column, with the resulting failure, as shown in Fig. 19; and this fact is still further illustrated in Fig. 20, where the buckling of the columns, following the failure of the terra cotta tile "fireproofing," caused settling of 10 or 12 ins. in the floor which they supported. A criminal method of construction is illustrated in Fig. 21, Continental Trust Building, Baltimore, where it may be seen that in order to place the "fireproofing" around the pipe, the webs of the tile were broken, thereby practically destroying the "fireproofing" value of the tile. This fact is

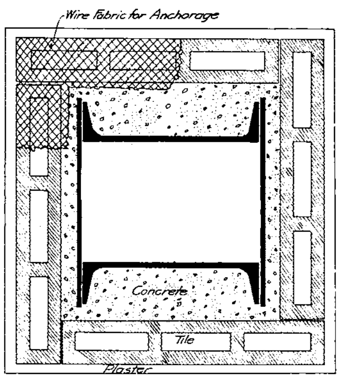

FIG. 25.—STEEL COLUMN FIREPROOFED WITH TILE AND AIR SPACE FILLED WITH CONCRETE.

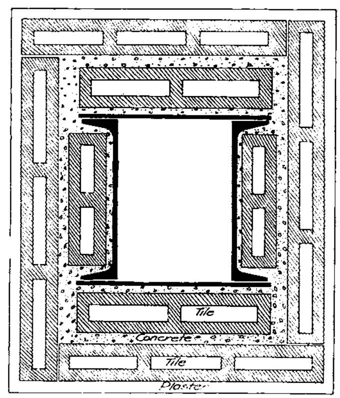

FIG. 26.—METHOD OF FIREPROOFING STEEL COLUMN WITH TILE AND CONCRETE.

still further illustrated in Fig. 22, showing that while the surface of the tile in the outer web is undamaged, the inner web is in some cases entirely destroyed. This fireproofing has then little or no value. In the section of the column shown in Fig. 23 the "fireproofing" is circular in shape, and while the tile are unimpaired, the presence of the pipes within this "fireproofing" renders the fire protection of little value, since the expansion of the pipes would very quickly strip the "fireproofing" from the column.

While a single encasement with plastered metal fabric forms a very inadequate protection, a double encasement of plastered metal fabric with an intermediate air space, as shown in the section of the column, Fig. 24, affords a very fair fire resistance. Where this plaster is Portland cement mortar, the resistance, of course, is very much greater than where hard plaster is used, because the fire quickly dries off the water of crystallization and leaves the latter an inert mass which is easily destroyed.

A few years ago a series of tests were made in Chicago, which consisted of cutting a long concrete column into short sections. These columns were 12 ins. square, and an effort was made to show the value of the "fireproofing" by contrasting the resistance of the unprotected concrete column 12 ins. square with the behavior of a section of the same column protected with 3 ins.

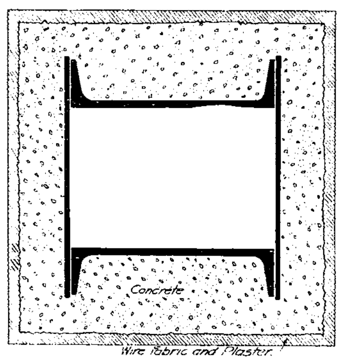

FIG. 27.—STEEL COLUMN FIREPROOFED ENTIRELY WITH CONCRETE.

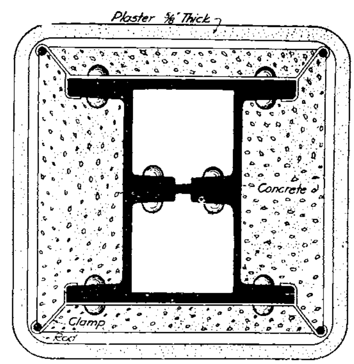

FIG. 28.—STEEL COLUMN FIREPROOFED WITH CINDER CONCRETE AND PLASTER COATING.

of terra cotta tile. As a result of these tests it was claimed the column with the terra cotta "fireproofing" had a greater resistance than the unprotected column and, therefore, terra cotta was an excellent "fireproofing" material. The fallacy of the theory evolved is whereas the tests showed that by fireproofing the column it would (as might be supposed) have a greater resistance to fire, it is also a fact that the 12-in. unprotected column would have had a greater resistance than the terra cotta "fireproofed" column if it had an additional thickness of 2 or 3 ins. of concrete.

A method of fire protection is shown in Fig. 25, where the tile encases the column and the interior space between the tile and the column is filled with concrete. Here will be seen another method of using a wire fabric as a means of anchoring the tile to the concrete. While the tile in this particular method of fireproofing may fail under heat, the concrete will offer resistance to the fire, but the question naturally arises whether or not the column protected to the full size with concrete would not be much more efficiently fireproofed than in the method shown. Fig. 26 shows a fairly efficient method of fireproofing with tile where concrete is used to fill in the spaces. Evidently in this particular

FIG. 29.—FAILURE OF FIREPROOFED FLOOR DUE TO EXPOSURE OF LOWER FLANGE OF BEAMS.

method attempt is made to utilize the hollow spaces, and it is possible this tile protected with a coat of concrete or tile would remain unchanged, but it is evident that an even more satisfactorily protected column would be obtained by the use of a very much smaller protective coating of concrete.

But, after all, experience shows that one of the best protections that can be afforded to columns is through the use of concrete, especially if there is an enclosing fabric, as shown in

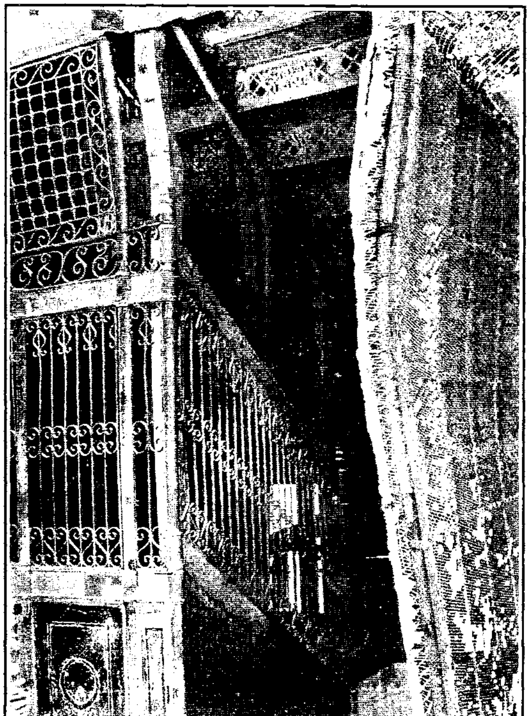

FIG. 30.—FAILURE OF PARTITION OF PLASTERED METAL FABRIC SUPPORTED BY ANGLE IRONS.

FIG. 31.—FAILURE OF TERRA COTTA PARTITION.

Fig. 27, which serves to bind together the outer plaster with the concrete itself.

In Fig. 28 the steel column is covered with cinder concrete. The 5/8-in. plaster coating on the outside of the casing of the steel will doubtless offer some protection, but even here the coating should be at least 1 in., to afford a reasonable protection.

Attention is called to Fig. 29, to point out how an otherwise good material may prove ineffective, because of defective design. The unprotected flat bands which reinforced the ribs on the under side of this floor failed in a fire and caused the collapse of several panels.

In the matter of partitions, little study is apparently given to their efficiency as fire barriers. It frequently happens that a light 1/2 or 1-in. channel angle iron supports two sheets of metal fabric, and the plastering on this makes a total thickness of perhaps 1 to 1 1/2 ins. Generally hard plaster is used, and the result is that a very moderate fire soon destroys the life of the plaster, and leads to expansion of the metal fabric and the angle irons, the partition failing, as shown in Fig. 30.

Where a Portland cement plaster is used, instead of hard plaster, the damage done is not nearly as great, and if the coating of plaster be sufficiently thick it will offer a reasonable barrier to ordinary fires. A very common partition consists of 2 or 3 terra cotta tile, with a coat of plaster on either side. The heat of the fire soon destroys the plaster and causes the expansion of the tile, with the failure of some of the webs, and generally results in the collapse of the partition. A view of such a condition is shown in Fig. 31, where the failure of the partition and column protection has caused a buckling of the columns and a consequent sinking of several inches of the supported floor.

It often happens that the protecting tile fireproofing is coated with an inch or more of cement plaster, which serves as a reasonable protection to the tile. If, however, the heat is sufficiently great and prolonged this plaster is stripped off by the failure of the tile.

Unfortunately, the view given in Fig. 32 shows a condition of usual occurrence, and shows how fallacious the idea that certain forms of fireproofing may be effective. In this case the

FIG. 32.—POOR WORKMANSHIP IN APPLYING TILE AS FIREPROOFING TO FLOOR, SHOWING BROKEN TILE AND UNPROTECTED STEEL MEMBERS.

FIG. 33.—FLOOR FIREPROOFED WITH TERRA COTTA WITH UNPROTECTED FLANGES.

workman, in applying the fireproofing, has either cracked or destroyed a portion of the web, thereby destroying the insulation of the air spaces and, therefore, subjecting the inner web directly to the action of the fire.

In Fig. 33 may be seen a similar condition, but the greatest danger here is the unprotected flanges of the girders. Such views as this can be secured in almost any large city in the country, and bring out strikingly the danger of bad workmanship in destroying whatever merit there may be in this form of fire protection. The plaster too often imperfectly fills the joints of the abutting tiles, which still further offers another means by which the flames can dangerously heat up the structural member which the tile has been designed to protect.

There were a number of buildings in San Francisco in which

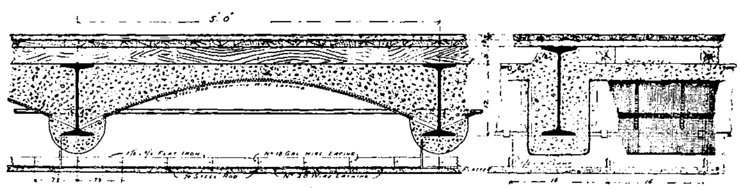

FIG. 34.—TYPE OF SUSPENDED CEILING.

the floor was protected by a suspended ceiling, and while the ceiling in some cases was destroyed because of its flimsy character, nevertheless it afforded sufficient barrier to protect the floor through the hottest part of the fire. A suspended ceiling, when properly designed, acts as an admirable fire barrier, and in case of its being destroyed or seriously damaged in a fire, can be replaced at low cost and without injury to the floor.

In Fig. 34 may be seen a type of suspended ceiling. Here the beams supporting the floor are protected by a coating of concrete, the light flimsy character of the unprotected support of the ceiling indicates one of the great weaknesses of this type of construction. The metal fabric which it supports is generally covered with a hard plaster, and the destruction of this plaster through fire allows the heat to attack the carrying member with the result that it either breaks or expands sufficiently to cause the failure of the ceiling. Where this is protected by a coating of Portland cement mortar, it is much more efficient. It is apparent, I think, from the photograph that such a ceiling offers an admirable barrier and protects the floor from the direct action of the flames. But even under this condition it is necessary that the floor in itself be properly fireproofed, so that the suspended ceiling will form an additional barrier. It frequently happens that in an attempt to

FIG. 35.—FAILURE OF SUSPENDED CEILING.

hold in place the metal fabric for the purpose of aiding in the protection of the structural member the metal comes too near the surface, or is so insufficiently protected by a coating of plaster that it serves as a means of transmitting heat directly to the member intended to be fireproofed, which action not only destroys the fireproofing, but in some cases has been sufficiently strong to soften the structural member.

In Fig. 35 may be seen a view of a suspended ceiling, which has collapsed by reason of the failure of the supporting clips, although in this particular case there was no damage to the floor itself.

Figs. 36 and 37 show two types of floor construction where

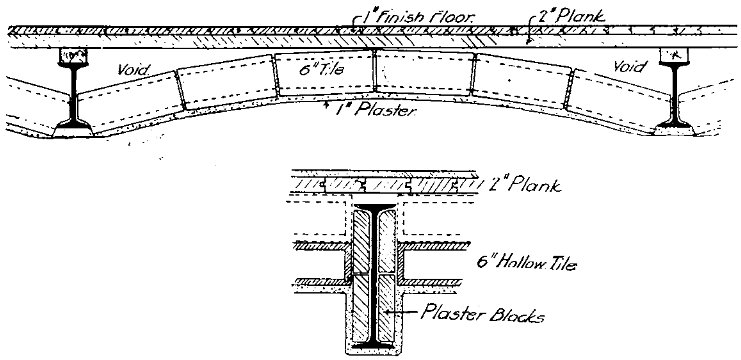

FIG. 36.—COMMON TYPE OF FLOOR CONSTRUCTION GIVING INSUFFICIENT PROTECTION.

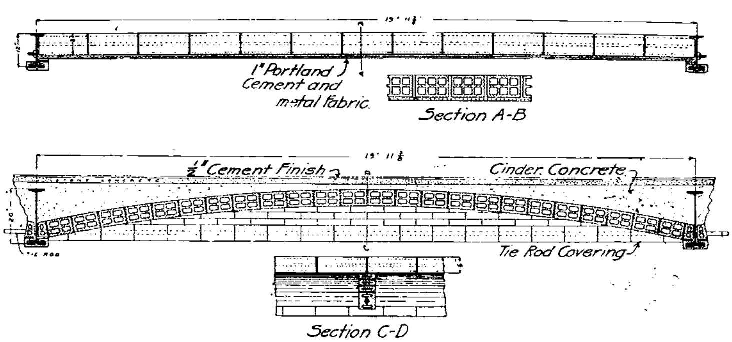

FIG. 37.—FLAT ARCH CONSTRUCTION WITH INSUFFICIENT PROTECTION OF SUPPORTING BEAMS.

there is insufficient protection. If the tile is defective and improperly laid (and has been broken so as to make defective joints and openings, as shown in Fig. 21), there is afforded a very poor protection against fire.

In Fig. 37 may be seen a section of the flat arch which is commonly used in many of our large buildings. The behavior of fireproofing of this kind is clearly shown in Fig. 38, where the web has failed over a large area. The failure of this web was unquestionably due to the unequal expansion of the lower and

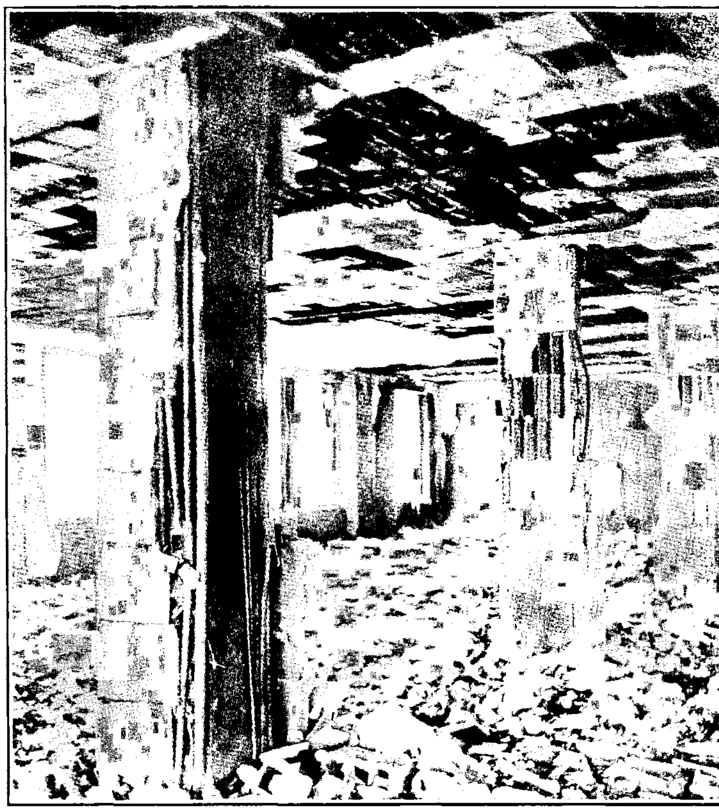

FIG. 38.—FAILURE OF TERRA COTTA FIREPROOFING THROUGH CRACKING OFF OF LOWER WEBS.

upper webs, and the connecting web being of insufficient strength, the lower web, or that subjected to the direct heat, cracked off.

Where concrete is used for the floor of a building, it is necessary that the reinforcement shall be properly protected against fire. The Joint Committee on Concrete and Reinforced Concrete has very properly recommended that there shall be at least 1 in. of protection to the metal in slabs, and 1½ ins. in beams and girders, and 2 ins. in columns.

The roof is perhaps a part of the structure that receives little consideration from the architect or engineer who designs it, and it too frequently happens that the roof trusses are wholly unprotected against fire, presumably on the theory that since the roof of the building it not occupied, there is little danger from

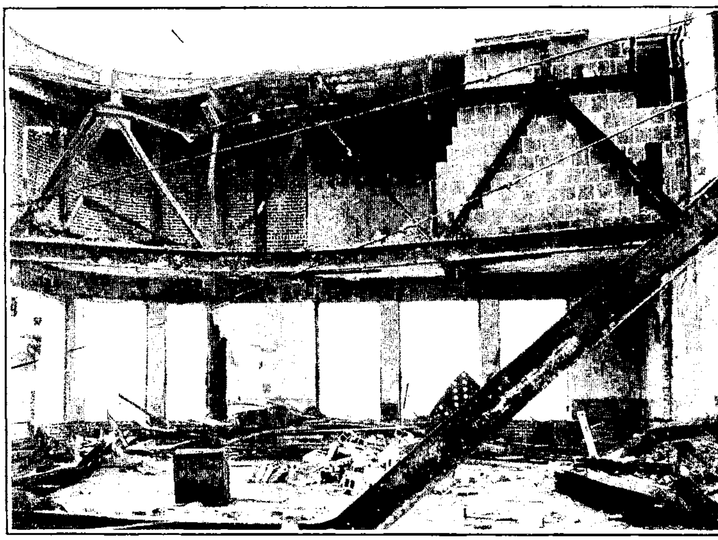

FIG. 39.—FAILURE OF UNPROTECTED STEEL ROOF TRUSS, MUTUAL LIFE BUILDING, SAN FRANCISCO.

fire, and, therefore, there is no necessity for fireproofing. It should be borne in mind, however, that the heat of the fire on the upper floor may be sufficiently great to destroy the ceiling, and the collapse of the unprotected roof trusses opens the building and leaves it to the mercy of the flames.

Fig. 39 is an excellent illustration of the failure of an unprotected steel roof truss in the Mutual Life Building, San Francisco. It is certainly as necessary, and perhaps more necessary, that the structural members of the roof shall have the same degree

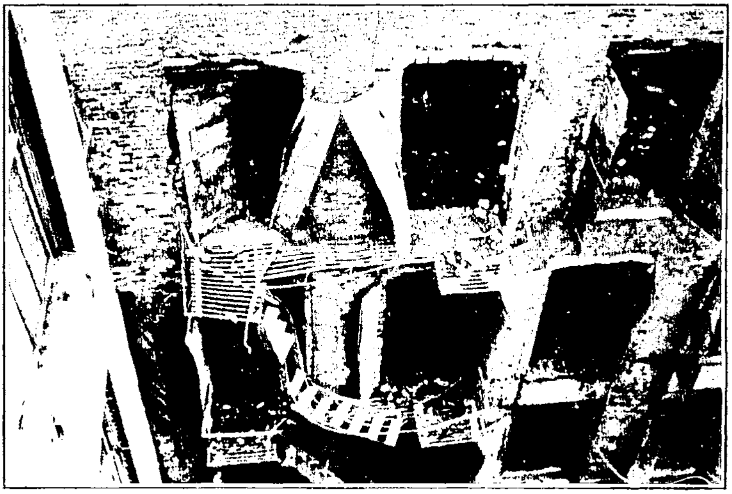

FIG. 40.—FIRE ESCAPES, ASCH BUILDING, NEW YORK, N. Y.

FIG. 41.—FIRE ESCAPES, SCHOOL BUILDING, COLLINGSWOOD, OHIO.

of fire protection as is accorded other parts of the structure. As previously pointed out, it is essential that a building shall have a maximum fire resistance both from within and without, and it is as necessary to protect the roof members, and thereby prevent their destruction by a fire in an adjoining building which would permit the fire entering, as it is to fireproof the ceiling under the roof, and thereby prevent the fire in the building destroying the roof.

Contraptions that the speaker has repeatedly criticized and scored on the ground of their lack of value, are the flimsy iron fire escapes, required by law in some of our large cities. He has frequently pointed out that it is difficult under ordinary conditions, unaffected by the hysteria that a fire produces, to walk down these steps safely, and how much more difficult it is to utilize them in case of fire, especially if they be unprotected, and pass windows where flames are breaking forth. It frequently happens that the fire destroys the fire escapes themselves, as shown in Fig. 40, the fire escapes of the Asch Building, which proved of little value as a means of egress for the occupants of this ill-fated building. Fig. 41 shows the Collingswood, Ohio, School Building, with its iron fire escapes.

It is high time that the fallacy regarding these flimsy structures should be exploded, and the laws which legalize them be repealed, and new ones enacted which will absolutely prohibit the use of such structures.

It is necessary that there shall be a proper means of exit from a building in the event of fire. In Europe the number of such exits is controlled by the number of occupants of the building. It frequently happens that enclosed stairways are protected by plain glass windows, and that the stairways consist of cast iron horses and marble treads; their valuelessness is illustrated clearly in Fig. 42, which shows the practically total wreck of such an enclosed stairway.

The Asch Building fire drew attention to a condition which is too prevalent in New York City, and while all the discussion was directed against the Asch Building, as a bad type of structure, we should not lose sight of the fact that within a stone's throw of this building are numerous other structures infinitely worse than the Asch Building as regards their fire-resistive properties.

It so happened that a fire occurred in the Asch Building, which brought this in the center of the stage, but those who inspected the conditions in the vicinity of the Asch Building realize that there are many buildings of infinitely poorer construction than this building—as defective as proved its provisions against a fire.

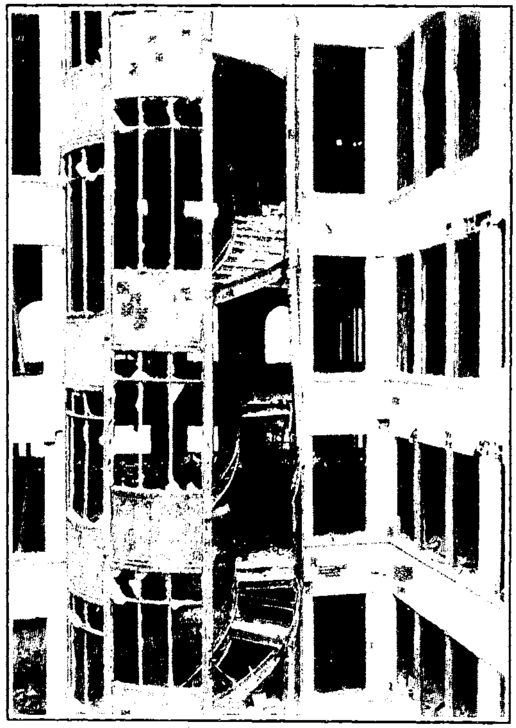

FIG. 42.—FAILURE OF POORLY PROTECTED STAIRWAY.

Probably the best type of fire escape is the fire tower. There are a number of types of such buildings, and two forms are illustrated in Figs. 43 and 44. The principle involved is that the fire stairway proper shall be shut off from the floors of the building, and that the entrance to this fire tower shall be from the exterior. In the case of the type shown in Fig. 43, it is necessary to go from the building to an open air vestibule, and then through a

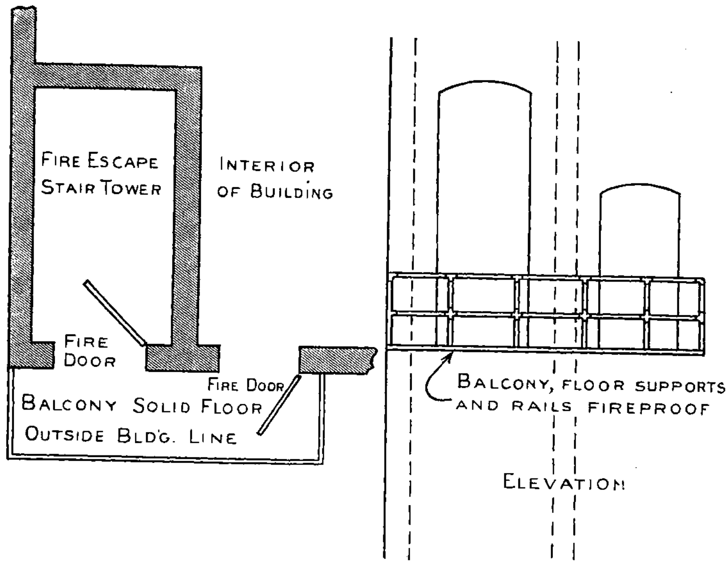

FIG. 43.—MODEL FIRE TOWER WITH EXTERIOR BALCONY.

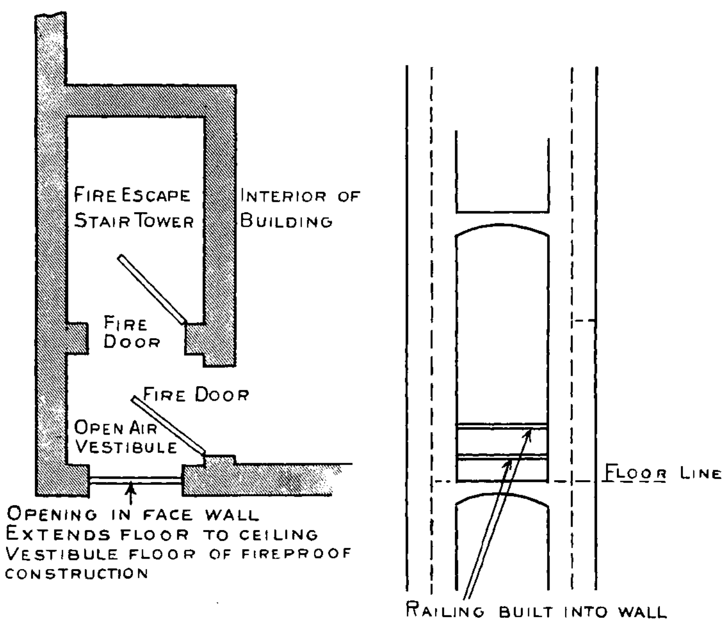

FIG. 44.—MODEL FIRE TOWER WITH INTERIOR VESTIBULE.

door into the fire tower. In this way the rush of flames into the fire tower is prevented, and enables the occupants of the building to escape with safety.

The foregoing illustrates a few of the many fallacies which prevail in the matter of fireproofing and fire protection, because of a lack of information on the subject. It is to be hoped that the fire-resistive properties of the various building materials and of various systems of protection shall be developed so as to make the subject so well known as to make possible a general knowledge of what constitutes first-class fire protection. While tests of the individual materials afford information as to their relative fire-resistive values, and while the work done in tests of separate panels affords perhaps a little better knowledge of their properties, nevertheless the real test is that of an actual building where the full force of expansion, due to the heat generated by the burning contents, is felt; such expansion produces the destruction which has been indicated in many of the foregoing photographs.

Fire protection is a study of the expansion of materials under heat, and in order to properly analyze the subject, the fundamental requirement is a knowledge of the expansion of the various materials and their rates of heat conductivity. Fire protection consists in applying to the structural skeleton a coating of suitable material of low heat conductivity and of sufficient thickness to afford it the requisite protection from the heat that is likely to be generated by the combustion of the contents of the building. It is, therefore, evident that greater protection must be afforded the contents of a warehouse than would be necessary in the case of an office building, and it is important that our building laws shall classify the various requirements as regards fireproofing in accordance with the character of the occupancy.

It should be a matter of gratification to the members of this Association, that cement is constantly gaining favor as a splendid material for fireproofing purposes, and it should be the duty of every member to study the question and become so familiar with the fire-resistive properties of this material as to see that it is properly applied for such purposes; it behooves the Association to establish the value of this material for fireproofing purposes so that structures may be intelligently fireproofed. The failure of a structure improperly fireproofed injures the standing of such a material, even though it be evident that it was a matter of bad design or workmanship, or both.

The inadequate laws of this country are gradually undergoing a change, and are being replaced by more effective ones. In this connection, we should not criticize our city fathers too harshly, for we should bear in mind that the laws of European countries, which we cite as models, are the result of the gradual evolution of laws originally as inadequate as many of the laws of this country. It is, after all, a matter of education and publicity, and the more the subject is discussed, the more the principles of fire protection are pointed out and the better they are understood, the sooner will be created that degree of knowledge which will lead to an intelligent revision of our building laws.

National Association of Cement Users.

PROCEEDINGS

OF THE

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EUROPEAN PRACTICE IN CONCRETE CONSTRUCTION.

Annual Address by the President,

Richard L. Humphrey.*

Two years ago, in speaking on the use of concrete in Europe, I discussed in a general way the progress that was being made and contrasted the conditions prevailing in various parts of Europe. It was also pointed out that in the artistic treatment of concrete the foreign engineer and architect undoubtedly showed greater skill than was shown in this country, and therefore obtained much more pleasing results. I further commented on the fact that the development of the use of concrete in certain countries was very much handicapped by restrictive building laws. It was my good fortune to again visit Europe last year and to inspect extensively various structures of concrete, covering the most important work west of the Russian boundary. I shall use this opportunity for enlarging upon my former address, pointing out the development and essential points of difference at the present time in reinforced concrete construction in this country and in Europe.

This visit to Europe and the inspection of concrete construction during the closing months of last year, was under more favorable conditions than on the occasion of my previous trip, in that I was a guest generally of the concrete associations, whose officers did all in their power to show me everything of interest. This was particularly true of my visit to Austria, where, as the Presi-

* Consulting Engineer, Philadelphia, Pa.

dent of this and Honorary Member of the Austrian Concrete Association, I was the guest of the latter during my entire stay in that country, and was under the devoted personal guidance of its Director, Karl Bitner. This gentleman, as you know, was a delegate to our New York Convention and one of the speakers at the banquet, and I wish again to express my heartiest thanks and appreciation for the courtesies extended to me and the unusual efforts which he made to render my visit a pleasant and profitable one. It is certainly true that this opportunity of inspecting the concrete buildings in Austria was a valuable one for the reason that some of the best examples of concrete construction are to be found in that country.

The Austrian Concrete Association has always manifested a great interest in the work of our Institute and showed a willingness to co-operate with us in every possible way. The unusual character of the program laid out and the rapidity with which various pieces of work were inspected was, I think, intended as a tribute to our American characteristics. I submit this interesting program. (See opposite page.)

A feature that impressed me most favorably was that my visits to the various buildings had been arranged for in advance and upon scheduled time. On our arrival at the building we were met by the architect or his representative, the builder, and the engineer in charge; in many instances the plans of the structure were tacked up at some convenient point, and before the building was inspected a representative who spoke English explained the particular points of interest in the structure. On Thursday night I was the guest of the Austrian Concrete Institute, the Austrian Association of Cement Manufacturers, Austrian Society of Engineers and Architects and the Austrian Clay Products Association. My here recorded acknowledgment of the signal honor conferred upon me but inadequately expresses the depth of my gratitude and the extent of my appreciation. The precision with which the progran was carried out, the completeness of the details and the warm hospitality extended to me by all those I met, has left its permanent record—one that I shall never forget.

During my visit to England it was my privilege to address the Concrete Institute in London, on October 26, 1911, on the subject of "Fireproofing" for which I was honored by the award of the Institute medal.

The various countries of Europe are progressing in the use of concrete, but many of the large cities are still handicapped by restrictive building laws; particularly is this true of London, where only recently have the London County Council Regulations permitted the erection of structures that might be termed reinforced concrete. Most continental countries show far greater skill in the application of concrete than is shown in England, where the British conservatism has resulted in heavy structures of very simple application. This is also true for the most part of the various cities in Germany. In France, in Belgium, and particularly in Austria a wider and less conservative grasp in the use of this material has resulted in the erection of structures

FIG. 1.—THE CONCRETE INSTITUTE MEDAL.

which are not equaled anywhere in the world. Certainly at the present time in Vienna I believe one may find the most extensive use of concrete that is to be found either in this country or Europe. The city of Hamburg is perhaps second only to Vienna in the number of its reinforced concrete buildings, and these two cities are the most progressive spots in Europe. I observed on this trip that more concrete buildings were in evidence in the outskirts of London and other English and continental cities than on my previous visit; in this country the same is true, probably for the same reason, viz., that the laws governing the erection of buildings are more liberal outside of than inside of the larger cities.

The development of the use of concrete is certainly much greater in Europe than it was two years ago. I do not think, however, that Europe as a whole shows as great a development as is to be found in this country. In certain parts of Europe, Austria, for example, is shown a greater knowledge and skill in the use of this material. In England, especially in London, where there were practically no concrete buildings to be found on my visit two years ago, there are now to be found many structures of reinforced concrete; although it is true that these are not within the limits of the authority of the London County Council, which permits only reinforced concrete for floors with masonry-bearing walls, and to a limited extent for columns. It is probable, since a recent revision of the London County Building regulations permits the use of reinforced concrete, that from now on many structures will be erected of reinforced concrete.

The materials in Europe available for use in concrete are still relatively more expensive than labor. As a result, the designer, for purposes of economy, finds it desirable to so shape his forms as to eliminate as much as possible all material which is not required for structural or protective purposes. The effect of this is to render the structure less massive and more pleasing in appearance. The abundance of extremely cheap unskilled labor and the presence of low-priced technically-trained labor is one of the great advantages in the erection of concrete structures in Europe. This is particularly true as to the foremen and labor bosses who, in many cases, especially in Germany, are technically-trained men, which is of course unusual in this country.

Another feature which tends to increased efficiency in the erection of concrete structures is the fact that there are governmental regulations which apply with sufficient rigidity to territory outside of the large cities. In large cities the regulations are necessarily much more rigid. There is a wholesome respect for the law throughout Europe—which is lacking in this country—with the result that each person concerned conscientiously endeavors to erect the structure in full accordance with the building regulations. In some countries, especially Germany, a contractor who is found guilty of dishonest practices loses caste and becomes discredited, which is, after all, the most effective way of preventing the construction of dishonest structures. I recall particularly a case in Stuttgart where what might properly be called a "Quantity" engineer, having assumed responsibility for the erection of the building, was arrested and sentenced to several years imprisonment by reason of the collapse of the structure of which he had assumed the responsibility. Another effective way of dealing with this subject is practiced in France, especially in Paris, where the building department acts merely as a custodian of plans; the law placing the responsibility for the structure on the architect, contractor and owner. Under the law, these three parties are held to be responsible for the collapse of the structure until their innocence is established. The use of cheap labor, especially women, to carry mortar and concrete in small tubs on the head, seems to be the usual method but hardly an effective one for handling concrete. In the erection of but two buildings did I see used the elevating machine, so commonly used in this country, for handling concrete.

The presence of a large number of women laborers on concrete structures was always a source of interest to me as was also the pittance that these women were paid for a day's work. A recent lecturer in New York stated that in African hunting expeditions the camp followers received about sixty cents a month. While these women do not receive so little, yet when you consider that in the one case the men were furnished their food, while in the other, the women had to supply it themselves, the wage paid the women (in some countries equal to 16 cents and as low as 12½ cents a day) is extraordinarily low and you can appreciate why elevating and conveying machinery is doubtless more expensive than labor. The almost universal limit of about 5 stories or 22 metres in the height of all structures renders elevating and conveying machinery relatively unimportant. When, however, speed in the erection of concrete structures becomes important, Europe will be obliged to resort to mechanical means for elevating and conveying concrete, as the method of carrying concrete in tubs on the heads of the laborers is too slow for proper continuous placing.

Fig. 2 is a view of the memorial church at Berndorf, the industrial village of the Krupp works, just outside of Vienna, in which will be seen a number of the women laborers who are engaged in carrying mortar and concrete in the manner above described. These women, in spite of their skirts, are able to climb ladders with almost the same speed as men.

The use of round timbers instead of sawed, as studs for forms and scaffolding, is quite general. Where a splice is necessary, the two parts are tied together with rope or chain. They do not use nails, therefore, these timbers can be used over and over again and last for such a length of time as to make the cost relatively very low. Another interesting construction detail is the method of splicing uprights through the medium of two iron rectangular iron bands surrounding the uprights, which are clamped tightly together by wedges between the inside of the band and the face of one of the uprights, which is a very simple and readily adjustable device. This particular device was used on the props in the construction of the Commercial Museum in Vienna.

The development in the use of reinforced concrete telephone

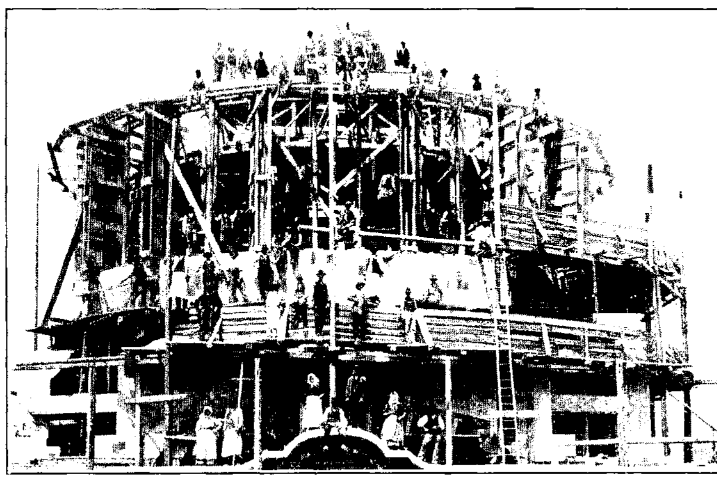

FIG. 2.—DOME MEMORIAL CHURCH IN BERNDORF, AUSTRIA.

and telegraph poles is even greater than it was on my previous visit and the experience gained has brought forth many ornamental and efficient poles; the tendency for purposes of economy is towards a hollow pole, this being of greater necessity in Europe than in America; and in my judgment the cost of the concrete pole must be materially reduced, to effectually compete with the wooden pole in this country. The view shown (Fig. 3) of the centrifically molded circular poles in Bad Kösen indicates the uniformity and symmetrical shape of this pole. This circular form, however, is not necessary, and there are many hollow poles of ornamental character of square or octagonal design, notably four in Dresden, in the Exposition of Hygiene. The ornamental poles on the Augusta Bridge in Dresden further exemplify the beauty of this type of pole, the hollow interior affording an ideal place for running the electrical wires.

The method on making the hollow reinforced concrete pole

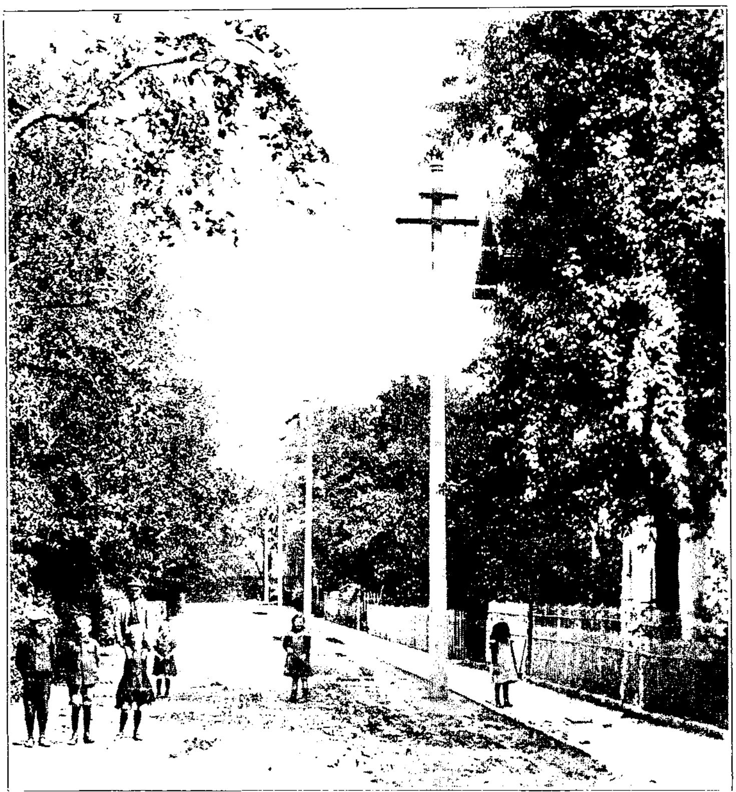

FIG. 3.—CENTRIFUGALLY MOLDED CIRCULAR TOWN ELECTRIC LIGHT POLES, IN BAD KÖSEN, GERMANY.

consists in placing the mold filled with concrete in a machine rotated at the rate of 600 revolutions per minute. The effect of this high speed is to force the concrete against the walls of the mold by centrificial action, gradually compacting the concrete and forming a hollow space in the center of the pole in which the excess water and laitance gathers producing an exterior surface of a hard and uniform texture which greatly adds to the appearance of the pole. The molds are generally kept on the pole until properly hardened.

The poles erected in connection with the Danish railways in Copenhagen, Denmark, are hollow, 36 ft. high, and were molded by the hand process and the tests showed them to be very stiff and capable of resisting high loads.

It has been found in Europe, especially where lumber is becoming scarce, that reinforced concrete poles are much more efficient and less costly than wooden poles; that the maintenance of the line is less expensive and the permanent life of the pole much greater. It appears to me to be evident that in order to effect the desired economy in the cost of manufacture of this class of concrete products, it is necessary to turn out a great many each day; inasmuch as they are coming into general use in Europe, there is a constant decrease in the cost of manufacture.

The poles illustrated in Fig. 4 are those at the plant of R. Wolle in Leipsic, Germany. There seems to be a general use for concrete poles for carrying high-tension lines, especially where the pole must be of considerable height. It is claimed that the cost of maintenance of such lines is very much less than for wooden poles. This probably accounts for their popularity.

The continued use of reinforced concrete poles in this country leads to the belief that as the number of poles and skill in making them increases they will become more serious competitors of the wooden pole and will in time replace the other forms of telephone, telegraph and electric transmission poles. They can be molded to suit the particular conditions of almost any height and can be so anchored in the ground as to enable them to maintain a rigid position in almost all soils. The high tension transmission line poles of reinforced concrete, used in connection with the Pennsylvania Railroad tunnels,* which were erected on a mattress in the marshy land of the approaches on the New Jersey side, are an illustration of the superior excellence of this type of pole.

Another matter which was of considerable interest to me was the form of chimney developed by Captain F. Möhl in Copenhagen. This consists of a four-leaf-clover section at the base

* See *Proc. N.A.C.U.*, Vol. VIII, p. 759.

which gradually merges into a circular at the top. A number of these chimneys have been erected, some of considerable height, and it is said that they are more economical and much more suitable than the ordinary circular stack.

The reinforced concrete barges shown in the illustration were photographed (Fig. 5) at the place of manufacture in Livorno, Italy. These particular barges were used for handling coal and seemed to be in every way thoroughly satisfactory. When the Italian government first used reinforced concrete for armor plate,

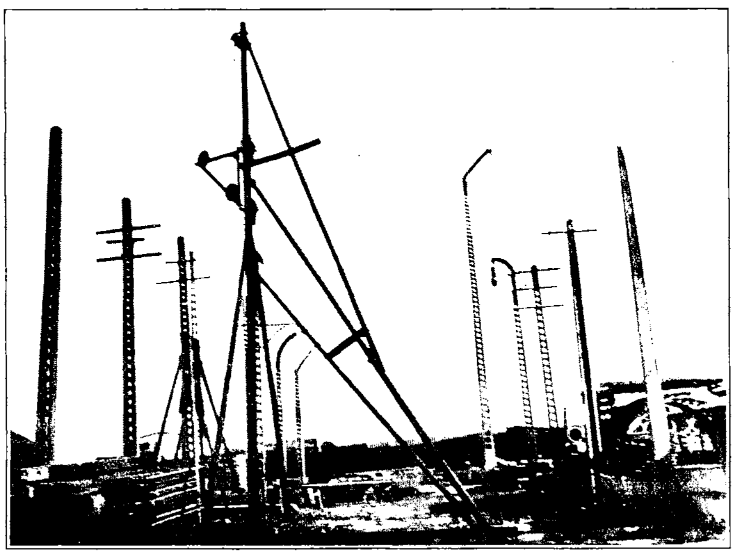

FIG. 4.—TYPES OF REINFORCED CONCRETE POLES AT PLANT OF R. WOLLE, LEIPSIC, GERMANY.

there was much amusement manifested in this country and the average person believed that the weight of this material would sink the boat. Its use, therefore, to form the entire hull of a boat would seem even more quixotic. Barges and other vessels, especially battleships, are made entirely of steel, which is heavier than concrete; and when you consider that the floating of the vessel is a question of buoyancy depending on the lightness of the material and character of the air-tight compartments, it is evident, I think, that any material properly designed will be sufficiently buoyant for practical purposes. In the case of the armament of concrete, which is much lighter than steel, the thickness can be much greater and the toughness of the former material renders it a better protection. I believe with the development of the art of reinforced concrete boat construction, these vessels will in the future come into general use and will prove most serviceable and economical, both as to first cost, maintenance and durability.

It is not so very many years ago that the concrete barge was a novelty and regarded by many as a freak application of cement. However, a few years' trial of these boats has resulted in striking economy and in many places I found concrete barges being used,

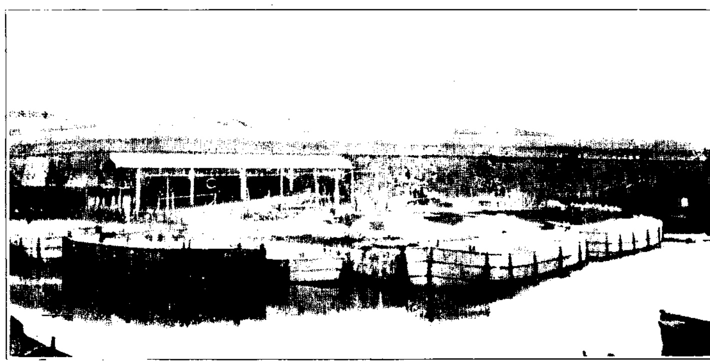

FIG. 5.—REINFORCED CONCRETE BARGE FACTORY AT LIVORNO, ITALY.

especially of the canal boat type, for handling coal and other materials. It has been found that the durability and serviceability of these boats render their ultimate cost very much less than boats made of any other material. There have been a number of such boats used in this country, notably in connection with the construction of the Panama Canal, and in my judgment there will be an even greater use of them in the future.

The constant study of the reinforced concrete railroad tie (with somewhat disappointing results at the present time) shows a desire for a tie of this type. In parts of Europe where steel or wooden ties are readily obtained at reasonable cost, the concrete tie does not make much headway. In other parts where ties of timber and steel are expensive, for instance in Italy, where the steel and wood tie is at least as expensive as the concrete, there has been considerable development and the officials informed me that more than 300,000 were in use in the Italian railways and that there were contracts for upwards of a million. The tie, however, has not a very great life when used in main line service, where it is subjected to the frequent passage of heavy locomotives. In what are termed secondary lines and sidings, ties

FIG. 6.—REINFORCED CONCRETE TIES IN MAIN LINE ITALIAN RAILWAY AT PORTO NACCIO, ITALY.

of reinforced concrete are reasonably effective and in Italy have as much as six or seven years of life.

I inspected some railroad ties just outside of Rome and found that these ties (see Fig. 6), which had been in service for about two years, were not wearing very well. A number of ties having crushed just inside the rail.

The method of fastening the tie consists of the use of a wooden block, cylindrical in shape, which is driven into the hole molded in the tie and an ordinary wood screw which fastens the rail to the tie. When the threads in the block are worn by use, the block is replaced.

Fig. 7 is an illustration of the section of track of the London and Southeastern Railway at Knockholt station in which reinforced concrete ties have been used. These ties, I think, are not of as good design as those used in the Italian railways. They have been in service about two years. A number of them have failed in the manner shown in the illustration (Fig. 8) by the concrete crushing just inside the rail. It is my opinion that the difficulty in reinforced concrete ties is in a lack of proper analysis

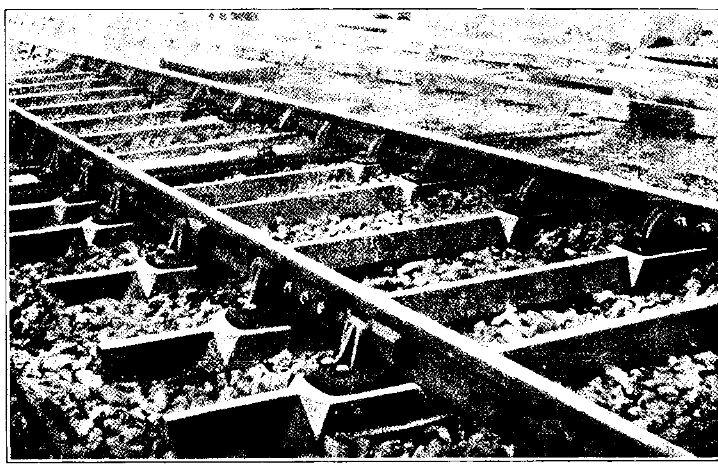

FIG. 7.—REINFORCED CONCRETE TIES IN SECTION OF LONDON AND SOUTHEASTERN RAILWAY AT KNOCKHOLT STATION.

of the stresses, and that a tie could be so designed as to properly care for these stresses and thus prevent the breaking down of the tie in the manner just referred to. With this point cared for the life of the tie would be greatly prolonged.

It was the universal opinion of track men that through the use of reinforced concrete ties the cost of maintenance could be materially reduced and the alignment of the track much more readily maintained. It is, however, on curves that the ties are least effective and their life very brief. Another objection seems to be that the use of the concrete tie usually results in a rigidity of roadbed which is extremely undesirable from an operating point of view, with the result that many devices have been tried with a view to introducing some elastic medium which will absorb the shock of passing locomotives.

At the Exposition in Turin were shown a number of reinforced concrete ties with wood blocks, fiber cushions, and other similar elastic shock absorbers, placed in the tie with a view to increasing its life. In most cases the design of the tie seemed

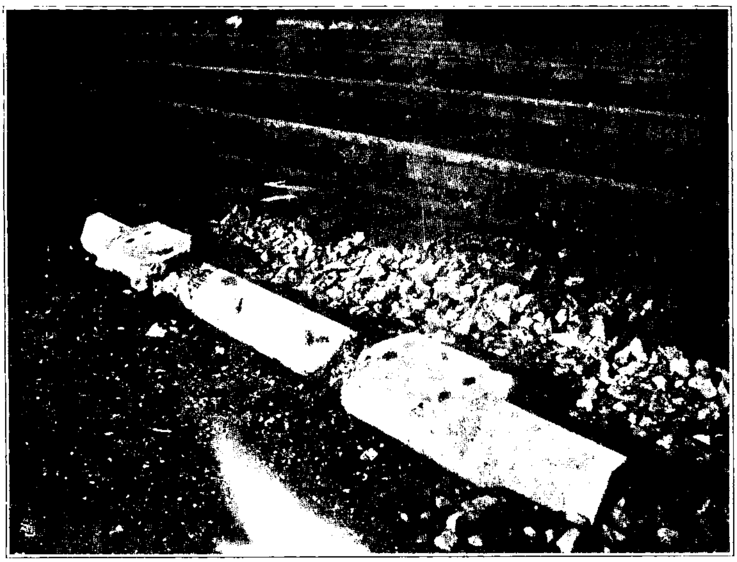

FIG. 8.—MANNER OF FAILURE OF REINFORCED CONCRETE TIES IN LONDON AND SOUTHEASTERN RAILWAY.

to be at fault; many of them had been developed by mechanics not skilled in structural designing, with the result that the reinforcement was not properly placed with regard to the stresses, especially those of impact; and it appears to me that the concrete tie problem can only be solved with a due consideration for these stresses.

Every one of the railroad officials who has had to do with concrete ties in Europe feels sure that a tie will be developed which will overcome the objections above indicated and reduce the initial cost to a point where its life and reduced cost of maintenance will make it the cheapest railroad tie.

The objection in this country to the reinforced concrete tie, namely, its rigidity under moving loads and the consequent objectionable hammering to the locomotive, can be cared for by the introduction of an elastic cushion in the shape of fiber or wood. I believe the concrete tie will be the tie of the future and its first cost will prove of minor consideration when the reduced cost of maintenance and durability is considered.

Another interesting development in the use of concrete is in connection with sewers or conduits of circular or elliptical form in which the walls are made up of segments of concrete, which after being placed in position are grouted or cemented together, forming a solid ring. There were a number of cases where unusual economy had been effected through the use of these sewers. In some of them the segments were grooved along the axis and around the circumference in which the reinforcement was placed.

The use of reinforced concrete for the lining of sewers and tunnels, in my opinion, is a very important application. The possibility of molding these blocks and placing them in position, and filling the space between the roof and the ring with concrete forms a very simple and effective method of tunnel lining, the application of which is cheaper than brick and also cheaper than concrete construction where tight forms must be constructed and maintained in position until the concrete has properly hardened. In the segmental method, with the completion of the ring, the concrete backing may be readily placed in position and but little shoring will be necessary until the concrete has set.

Another extremely interesting matter was the use of reinforced concrete pipe of varying lengths which was laid as shown in Fig. 9 to conform to the general contour of the ground, the connections and adjustment being effected by means of loose sleeves slipped around the joints. After the pipes and sleeves are in position the spaces between the sleeves are grouted solidly to the pipe This application is in advance of anything we are doing in this country. Sections of reinforced concrete pipe laid in this manner, in lengths of 12 feet or more, would have great possibilities for use in pressure lines. The pipe in the illustration were made in a machine not unlike a lathe. The reinforcement was placed around a core rotating horizontally and a very stiff mortar thrown against it. After the mortar had been built out to the requisite thickness, the pipe was wrapped with cotton bands four or five inches in width. The pipe was then removed and the wrapping kept wet until the mortar had set, when the

FIG. 9.—REINFORCED CONCRETE PIPE OF VARYING LENGTHS IN USE IN SWITZERLAND.

bands were pulled off. This method of construction naturally requires a great deal of labor and even if considered desirable would be entirely too expensive for use in this country.

Fig. 10 shows a cement products yard in Vienna and particularly illustrates the concrete ducts which are being used in that city. These ducts have longitudinal recesses in which reinforcement is placed and the remaining space filled with cement mortar; this stiffens the ducts and holds them in position. It seemed to me there was an excellent opportunity for this type of construction in this country. When properly cemented in position, the ducts formed were in every way desirable and I am told that the cost is much less than that of terra cotta or other material.

During my last visit in Vienna I had occasion to refer to the use of concrete pavements and I find that this type is coming

FIG. 10.—CEMENT PRODUCTS PLANT OF PITTEL AND BRAUSEWETTER AND E. GAERTNER IN VIENNA, AUSTRIA.

into gradual use. The pavement inspected on my previous visit and reported to you two years ago had been laid four or five years and during my last visit I found these concrete roadways still in excellent condition and that they had not been repaired. The city of Vienna was engaged in laying considerable yardage of these pavements, especially around the Royal Palace. This pavement was of great width and was entirely of concrete. I am absolutely convinced of the durability of these pavements and repeat what I have stated in my previous address, that I believe they will come into general use.

The tank of reinforced concrete in use at the coal mines, in Rotherham, England, to remove the coal dust from the water coming from the coal washery is of considerable interest. This water is pumped into the tank, the coal dust is removed and the clean water returned to the washery. This coal dust is used in briquetting coal. Steel tanks are not available for this purpose because the sulphur in the coal would so corrode the steel as to make its life extremely short. The concrete tank has proved highly satisfactory not only in its resistance to the action of sulphur but in its water-tightness.

I commented on the artistic use of reinforced concrete in bridge construction in my previous address, but the matter is so striking that I cannot help referring to it again. The innum-

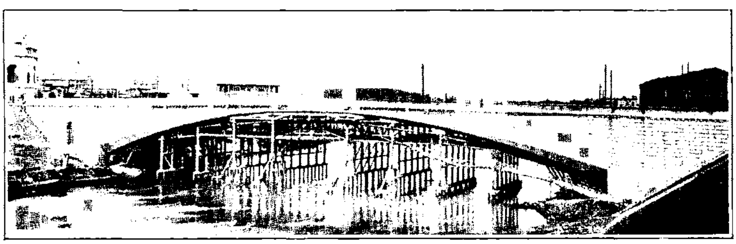

FIG. 11.—MEMORIAL REINFORCED CONCRETE BRIDGE CONNECTING HISTORICAL AND ART EXPOSITIONS OVER TIBER, IN ROME, ITALY.

erable bridges throughout Europe, carefully designed, carrying railroad as well as ordinary highway traffic, are monuments to the ability of the European engineer. The designs are for the most part graceful and show a wide diversity in artistic treatment.

A structure of great beauty is the Memorial Bridge (Fig. 11) in Rome connecting the Historical and Art Expositions, located on opposite sides of the Tiber. This bridge was built by the Hennebique Construction Company and is an example of European engineering skill. By reason of floods, it was necessary to construct the centering on which this bridge was built, of reinforced concrete—which is unusual and the first application of the use of reinforced concrete for centering that has come to my attention.

The bridge has a span of 100 meters and is built in imitation of the native Travertine stone; the beauty of this is fully as great as the artificial Travertine stone to be found in the New York station of the Pennsylvania Railroad. This structure was built by the Italian government, and many severe tests were applied with but extremely slight deflections.

The manner in which this bridge was tested is also of interest. A commission was appointed to conduct the tests for the government. These tests consisted in moving heavy steam rollers and marching soldiers in a solid mass over the bridge; particularly interesting was the loading of the bridge solidly with soldiers and studying the effect of their cadenced step on the structure.

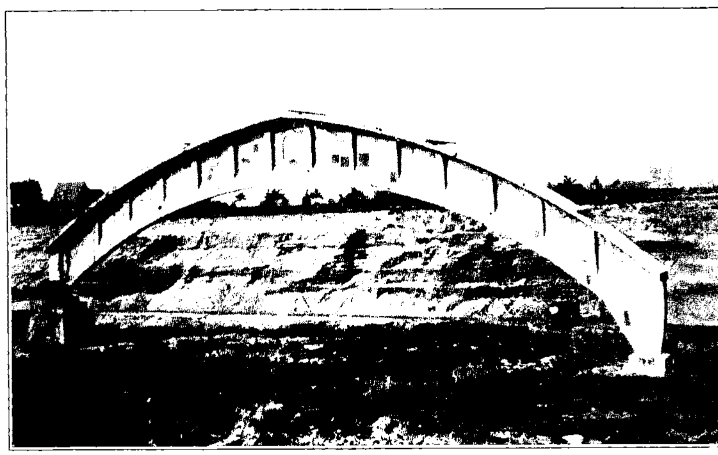

FIG. 12.—REINFORCED CONCRETE TRUSS 113.8 FT. SPAN USED IN MAIN RAILROAD STATION IN LEIPSIC, ERECTED FOR TESTING IN COSSEBAUDE, NEAR DRESDEN, GERMANY.

I think it may be stated without fear of contradiction that reinforced concrete structures properly designed are less affected by vibratory and cadenced loads than any other structure. It is particularly noticeable that in structures of identical design as to carrying capacity, those of steel show more movement than those of reinforced concrete.

A most interesting structure is the truss (Fig. 12) erected initially by the firm of Dyckerhoff and Widman, at their plant in Dresden. It was erected for testing the actual strength and justifying the use of a truss of this type in the main railroad station in Leipsic. The arch was loaded in various ways and the deflections observed, and the tests were so satisfactory that it was successfully used in the structure. It is unusual in this country to go to the expense of erecting a structure of this kind and applying tests in order to satisfy the officials that it is amply safe. It would, however, be an effective means of preventing failures.

A matter that impressed me was the development of structures, many of them articulated, composed of separately molded parts, and the views herein presented exemplify some of the more remarkable of these structures. The practice of casting members and then pinning them together and encasing the connection in concrete is a development that seems to meet with favor, and while this may not appeal to many of the conservative engineers of this country, it seems to me that when this pin connection is of the same design as pin connected steel members, there is no reason why this type of structure, when properly designed, should not be more serviceable by reason of the concrete covering which makes it more durable than a structure of steel. The concrete trestle used in connection with the mine at Floreffe, Belgium, the lower portion of this is used for the county roadway and the upper portion for the handling of cars to the "tipple" from the coal mine, is an illustration of a remarkable development of this principle. I was informed that the parts of this structure were separately molded and afterward erected in place in a very short space of time and that the cost was considerably less than a similar structure of steel or of timber. There is a tendency towards systems requiring separately molded members, and it seems to me that such systems afford an opportunity for economy. The weak points in such structures are the joints, and with the same attention to these connections that is given to steel structures there is no reason why the joint in a concrete structure should not be stronger than the weakest part of the separate members.

A development of the Visintini system was to me somewhat surprising, since this system is very little used in this country; the early attempts to introduce it were unsuccessful, chiefly because of its cost as compared with that of other systems of reinforced concrete construction. In Europe it has a wide application for buildings and bridges. Fig. 13 shows the bridge being erected in Copenhagen, Denmark, with girders of system Visintini. This bridge, erected in connection with the new station that the State Railways were building, carries a street with two lines of electric trams over the railroad. The ornamental portion is entirely of molded concrete which was not subsequently treated. Where labor is inexpensive the cost of forms is not so important as the cost of material. In this country, where conditions are just the reverse, this system proves uneconomical. The bridge consists of deep girders spanned by beams all of the Visintini system. The latter spaced solidly so as to form a slab, under the railroad tracks and 20 inches apart between the tracks. I

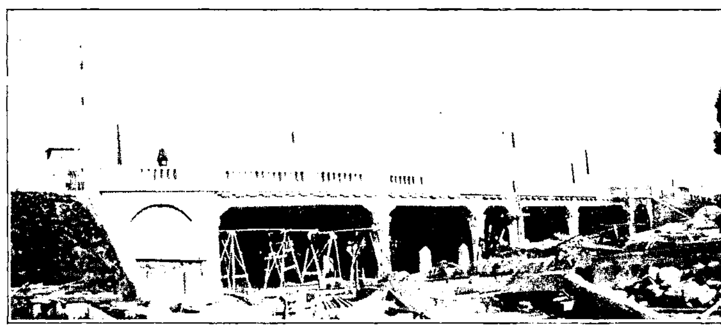

FIG. 13.—HIGHWAY BRIDGE OF REINFORCED CONCRETE OVER STATE RAILWAY TRACKS, COPENHAGEN, DENMARK.

think this bridge might be said to be a type of unit construction. Certainly the bridge, which was nearly completed, presented an extremely beautiful, ornamental appearance and far more desirable than a similar structure of steel. I believe that this method of construction, which is in a measure illustrated in the flat slab construction in use in railroad bridges in this country, possesses great possibilities in the matter of appearance and speed of erection. All the beams of the system could be molded and the structure then erected continuously, replacing perhaps an old structure, without interfering with the traffic.

An interesting type of girder construction is shown in Fig. 14, a highway bridge at Desna, Austria, which consists of a series of Visintini girders supported on piers of rather unusual construction.

The application of this system for arch ribs of a building is illustrated in (Fig. 15) the ceiling of a church erected in Aussig, Austria, and which I think is also an application of unit system. The lower flange of the rib of the arch is extended so as to support the Visintini beams which form the ceiling. Another type of structure which shows a trend in Europe that conservative structural engineers in this country might call dangerous is illustrated Fig. 16. This is a trussed bridge practically a development of the Visintini system, which forms a central span, with Visintini girders and beams used in the approaches.

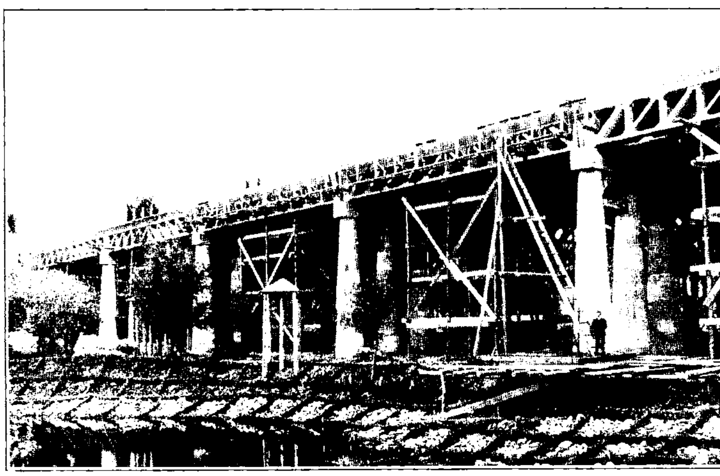

FIG. 14.—REINFORCED CONCRETE HIGHWAY BRIDGE, DESNA, AUSTRIA.

The photograph, Fig. 17, shows the coal bunkers of the extensive plant of the city gas works in Vienna. The one on the left side has most of the forms removed and illustrates the generally pleasing character of the structure, which is notable in view of the fact that it must be massive, in order to carry a large quantity of coal. The attempt to render this structure pleasing and ornamental could well be emulated by our American designers. The exterior surface is dressed with pneumatic tools and a color effect has been obtained which is not unlike that attained in the construction of the Connecticut Avenue Bridge in Washington, D. C.

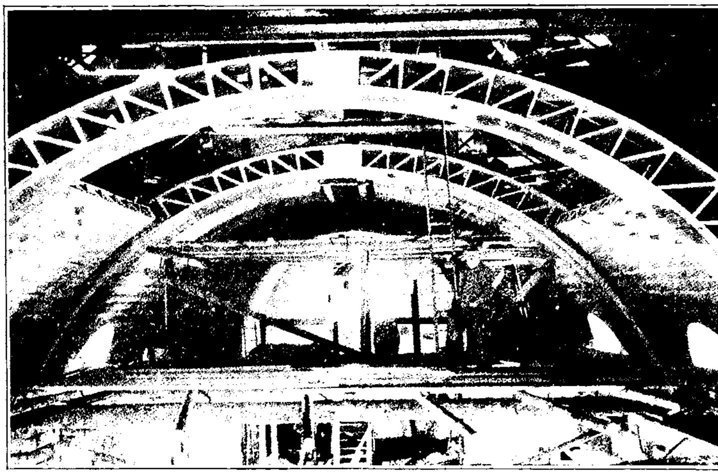

FIG. 15.—PORTION REINFORCED CONCRETE ROOF OF CHURCH, AUSSIG, AUSTRIA.

FIG. 16.—REINFORCED CONCRETE TRUSS HIGHWAY BRIDGE NEAR VIENNA, AUSTRIA.

We have, of course, many water towers in this country, but the thing that most impresses me in connection with those in European countries, is the thinness of the tank walls and the fact that they are constructed without the aid of waterproofing; the density of the concrete and the manner of reinforcing is sufficient to so distribute the cracks as to render them water-tight.

In connection with buildings abroad it would seem that more attention is given to the exterior and interior finish, even in factory buildings, than is given in this country; the skill used in

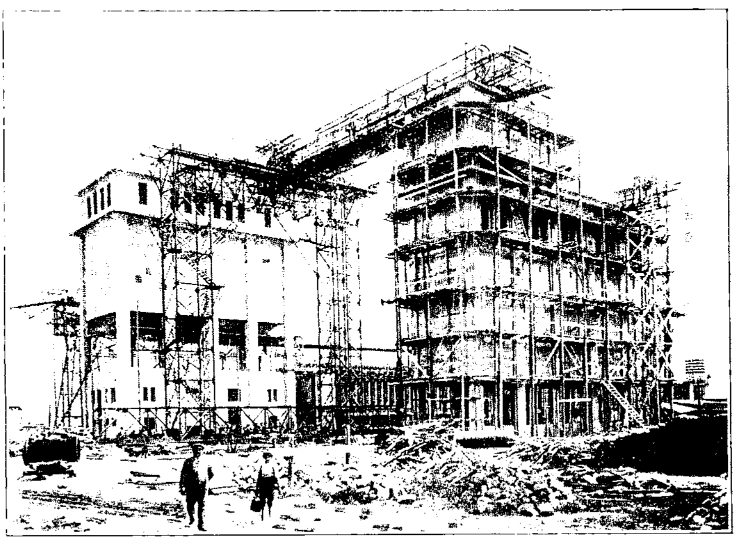

FIG. 17.—REINFORCED CONCRETE COAL BUNKERS, CITY GAS WORKS, VIENNA.

securing a pleasing finish, even considering the low-priced labor of Europe, is very rarely more expensive than the rough finish commonly used here. The tendency toward flat slabs and the elimination of as many beams as possible shows, I believe, an unmistakable turn, which is reflected in this country in the recent development of the flat slab type of construction. In many places the elimination of beams results in paneled effects through the use of girders between the columns and mortising and molding the connection between the slab and girder in such a way as to produce pleasing ornamental effects. There is also a tendency to panel the slab itself, which relieves its flatness and adds no little to the beauty of the interior finish. The use of much higher ceilings than are commonly used in this country renders flat slabs unnecessary for the distribution of light. The effect of the paneling is somewhat that of the Roman barrel arch, and this latter type of construction may be seen in the ceiling decoration of many European structures.

An excellent exterior finish having the appearance of gray stone was to be seen in the Cigarette Paper Factory in Vienna. This structure had been erected many years and the weathering had been so uniform as not to in any way mar its beauty. This building was illustrated in my address describing my trip of two

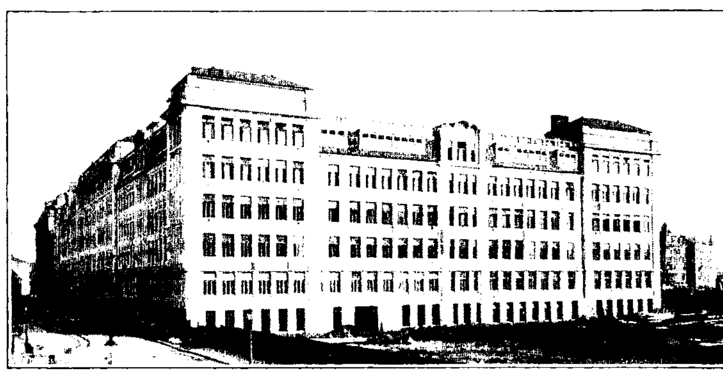

FIG. 18.—TRADE SCHOOL OF REINFORCED CONCRETE, VIENNA, AUSTRIA.

years ago and is again referred to because after an interval of two years the exterior finish of the building remains unchanged. The entire ornamentation is of concrete and serves as an excellent illustration of the artistic possibilities of this material.

The Trade School in Vienna (Fig. 18) is also an excellent example of the artistic treatment of concrete. The paneling and ornamental work are most excellent in character, and for this reason do not call forth the criticism which once was so rife in this country, where the crude structures which we erected left much to be desired from the æsthetic point of view. It is frequently the practice in Europe, especially in Vienna, to cast monolithic walls and tool them afterwards, in a manner to produce the effect of stone. This, however, does not appeal to me so strongly as the structure in which there is no attempt to imitate stone, but where the material is used to stand for what it is, producing pleasing ornamentation and a surface uniform in color and texture and free from those stains and cracks which are frequently seen in structures of concrete in this country.

FIG. 19.—CITY HALL OF REINFORCED CONCRETE, NEAR BADEN, AUSTRIA.

Fig. 19 is a view of the City Hall at Weikersdorf near Baden, Austria. The entire wall, with ornamentation, is of concrete without any attempt to imitate other material, which I think illustrates that this is the proper way in which to use concrete and that when so used the results are much more effective than where it is used in imitation of other materials.

A favorite form of exterior decoration is to apply plaster to the rough concrete and mold it in a manner to produce artistic effects.

The photograph of the Villa Figari in Genoa, Italy, shown in Fig. 20, is an illustration of the splendid possibilities in the artistic use of reinforced concrete. This graceful, beautiful structure needs no comment. The erection of this Villa involved a number of interesting problems in design which I think were met

FIG. 20.—VILLA FIGARI, GENOA, ITALY.

more successfully through the use of this material than would be possible through the use of any other. There are a number of plants in this country engaged in making ornamental concrete products of a very high order, and fully equal to some of the best work done in Europe, but the American designer does not at the present time seem to appreciate the adaptability of concrete for use in the ornamental structural portions of buildings; it seems to me that development along the lines illustrated in the Villa Figari opens a wonderfully promising field.

As the architect and designing engineer more fully realize the architectural possibilities of concrete and apply them in building construction with a due appreciation for the aesthetic, there will result such graceful structures as will entirely meet the criticisms and objections to the many cumbersome, ungraceful and unattractive structures which are being erected at the present time.

The desire to render even ordinary structures beautiful is

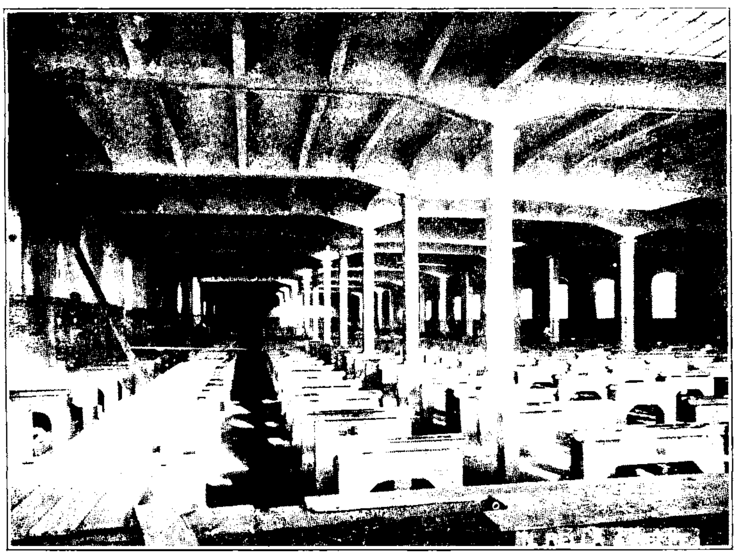

FIG. 21.—REINFORCED CONCRETE CAR BARNS OF CITY OF VIENNA, AUSTRIA.

particularly observable in Europe and it is, therefore, unusual to see even a mill building in which no attempt has been made to give it a proper finish. The eye for the beautiful is a matter of education and growth and I presume that in time we will develop similar tastes so that our mill buildings will be given artistic finishes. It should be borne in mind, however, that the cost of this work in Europe is considerably less than in this country, by reason of the cheap labor and because of the greater quantity that is done; they have acquired more skill and there are a great many more skilled men capable of doing this class of work.

The car barns of the city of Vienna, shown in the illustration (Fig. 21), is another development in the use of concrete which I think will become general in the future. This structure is built entirely of concrete, including the roof which has not been waterproofed. I understand that the cost of this structure was materially less than the cost of other types of construction. The span and lines of the girder was a matter of interest and is characteristic of the skill of the Austrian engineer.

A building of reinforced concrete which was brought to my attention during my visit two years ago, and which was then under construction, is the Urania Building in Vienna, which is devoted to the development of popular musical education. It has a rather difficult problem in acoustics which is of moment to those interested in concrete. The main auditorium has a floor and ceiling of reinforced concrete of considerable thickness; above and below this auditorium are smaller halls for musical entertainment. The large auditorium contains an organ, and there is no connection between it and the halls above and below, yet the Director states that when there is a concert in progress in the large auditorium it is impossible to hold a concert in either of the other auditoriums, because the sound of the music in the large hall is so pronounced as to seriously interfere with the performance in the other halls. This subject has received a great deal of consideration in Vienna and methods are now in progress to eliminate, if possible, by some insulating medium, the transmission of sound.

Another matter of interest was the work which the Austrian Association is doing in investigations and tests, not unlike those of our own Committee on Reinforced Concrete, except that the value of the work accomplished is greater because the work is much more extensive. They have conducted a comprehensive series of tests of columns and beams, the cost of the work being defrayed by the Austrian cement manufacturers, and has been under the auspices of representatives of the government, the Society of Engineers and Architects, the Austrian Concrete Association and the Austrian Association of Cement Manufacturers. The principal feature of the tests which were being conducted at the time of my visit was a study of the effect of the weight of wall in restraining the ends of beams; a number of different methods were being tried and it had been found that the stiff-

FIG. 22.—A RESTRAINED REINFORCED CONCRETE BEAM AFTER TESTING.

FIG. 23.—METHOD OF APPLYING LOAD IN TESTING REINFORCED CONCRETE BEAMS.

ness of the beam was materially increased through the weight of the wall.

Fig. 22 illustrates one of these beams after test. In some cases the beam rested on a pier, and in others it extended over; in still others it was imbedded in concrete, or laid up in a brick wall so as to approximate practical conditions.

Fig. 23 shows the manner of loading and observing the deflections. The method of applying the load is perhaps of interest. The load to be applied was carried by hydraulic jacks, the lowering of which brought the weight of this super-imposed load on the beam.

One thing that was apparent on my recent trip, and which must be a matter of great gratification to every member, is the high regard in which this Association and its work are held in Europe. It is taken generally as a model, and in many cases the character of the work done here and the value of its proceedings and discussions are so appreciated as to result in a number of Europeans becoming members in order to secure its publications.

There is also a cordial feeling of cooperative good-will between the various concrete organizations of Europe and our Association, which I hope may be fostered and that it may be possible through the interchange of delegates, papers, and in other ways, to extend this cordiality so as to obtain the advantages of the development in the art of concrete construction in various parts of the world.

This Association stands for education in the development of the proper use of concrete, and certainly it should be a part of its policy to encourage international co-operation, to the end that the development in this country may proceed with a full knowledge of what is being done by our foreign competitors.

National Association of Cement Users.

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THE USE OF CONCRETE IN MINES.*

ANNUAL ADDRESS BY THE PRESIDENT,

RICHARD L. HUMPHREY.†

The use of concrete in place of timber in mines dates back a number of years, but it is only within recent years, coincident with the development of the use of reinforced concrete and consequent economies in construction, that it has come into more general use, especially in Europe where the policy of building permanent works in connection with mining operations is in sharp contrast with the general practice in this country of building temporary structures.

During trips to Europe the speaker has given this matter considerable study and has visited the principal mines in England and the Continent with a view to preparing a report for the United States Bureau of Mines, and it is with the permission of the Director of that Bureau that this paper is presented.

During these visits to Europe the inspections were of works connected with the mining of coal. The most striking feature of the collieries in Continental Europe is the permanent character of

* Address delivered with permission of the Director, U. S. Bureau of Mines.

† Consulting Engineer, Philadelphia, Pa.

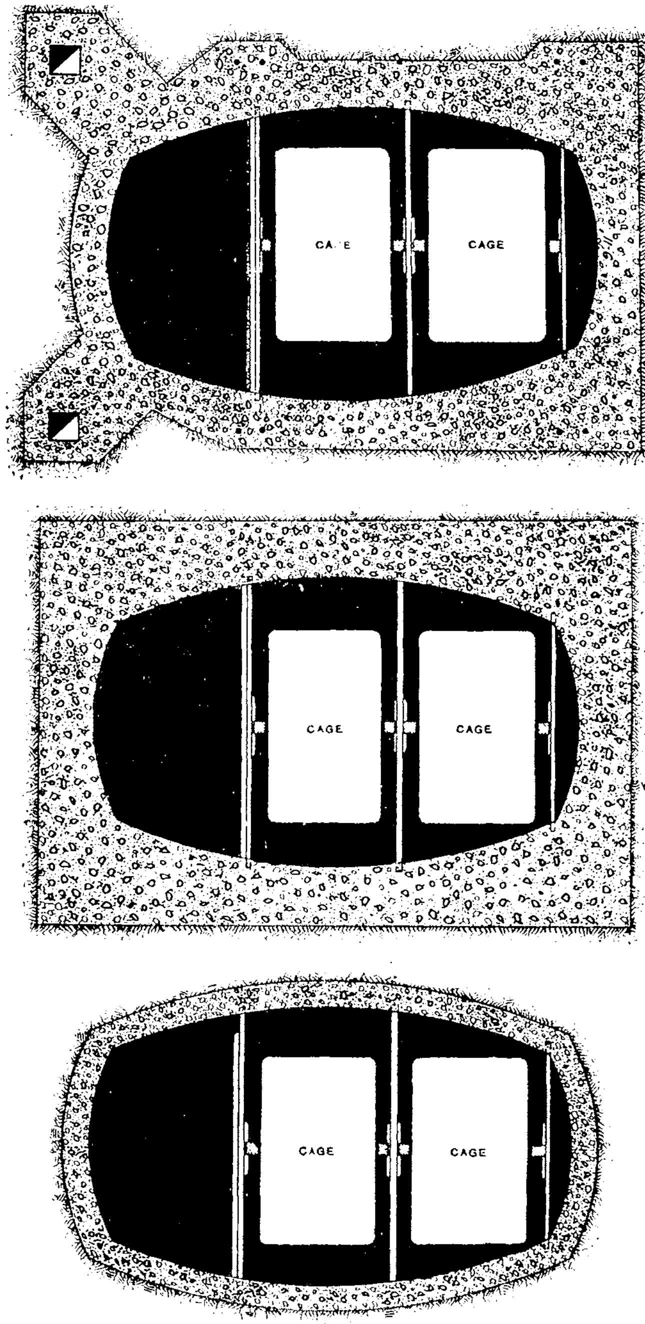

FIG. 1.—SECTIONS OF CONCRETE SHAFT LININGS AT BRIDGEPORT COLLIERIES, PENNSYLVANIA.

the head works, shafts, entry chambers and galleries. In the care of the miners, much better facilities are provided than is the case in this country or even in England. In most cases governmental regulations make this compulsory. When one visits a German mine it is almost a shock to see the miners coming from the mines with clean faces and clothes instead of the unkempt appearance which characterizes the miners in America as well as those in England. The regulations prescribe a change of clothing on entering the mine; and on leaving, after a bath, the miner replaces his mine with his street clothes. It is a revelation to an American to see miners free of coal dust and soot, leaving the mine clean and neat and of respectable appearance. The system that makes cleanliness a necessity also gives careful consideration to the structures entering into mining operations. The shafts both in England and in Continental Countries are almost always permanent in character and are generally of concrete. When you consider that in some parts of Germany the shaft is some three thousand feet deep, you can readily understand that in order to operate such mines a lining of a permanent character is necessary. These linings are installed in various ways; the shafts are either circular, elliptical or nearly rectangular in section. A common method is to build the usual forms and deposit concrete between the form and the walls of the shaft. The illustration, Fig. 1, is of shaft linings used in the Bridgeport collieries in Pennsylvania.

In Europe it is the more common practice to use the arrangement shown in Fig. 2, which consists of a movable form with a work platform having an opening in the latter through which the material is removed; as the form sinks into the mine, sections of the ring are concreted as shown, the method being somewhat similar to the construction of a chimney excepting that the concrete is deposited downwards instead of upwards. In very deep shafts it is the practice to place at intervals a cast iron ring which is forced rigidly against the walls of the shaft and serves as an additional support for the lining. It is the speaker's opinion that this is an outgrowth of masonry linings (stone or brick), and the practice is not changed when concrete is substituted. This cast iron ring is placed in sections in the shaft, fastened and grouted solidly to the wall. Where there is much water, provision is generally made to drain it as the construction proceeds.

In the method shown in Fig. 2, the materials are generally lowered to the platform and the concrete is mixed by hand or with a small mixer and deposited from this platform.

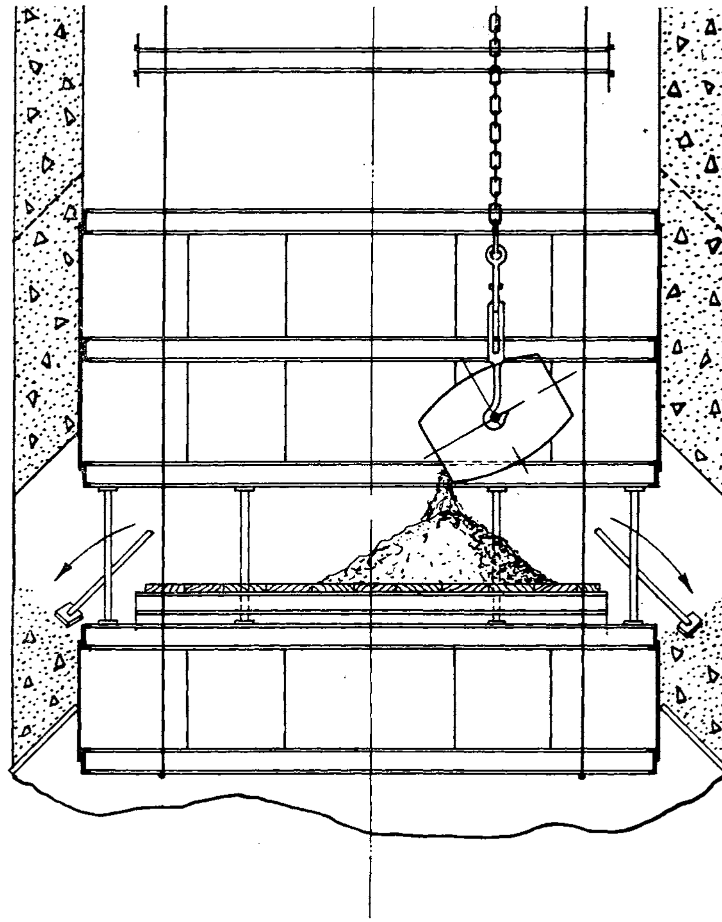

FIG. 2.—APPARATUS FOR LINING SHAFTS WITH CONCRETE.

At Gelsenkirchen, Germany, this method was used for lining the shaft which was 6 meters (about 20 ft.) in diameter; the form was moved about every 3 or 4 days. Another method of lining consists in molding the ring in segments (Fig. 3), allowing these to harden and then placing them in position in about the same manner that the cast iron segments previously described are placed. These blocks or segments of rings have grooves around the edges and in these grooves (both horizontal and vertical) the reinforcement is placed; when a section of lining is thus completed the space between the ring and the wall of the shaft is solidly filled with grout which is introduced through a hole in the center of the block. Where this method of lining has been used it has proved very

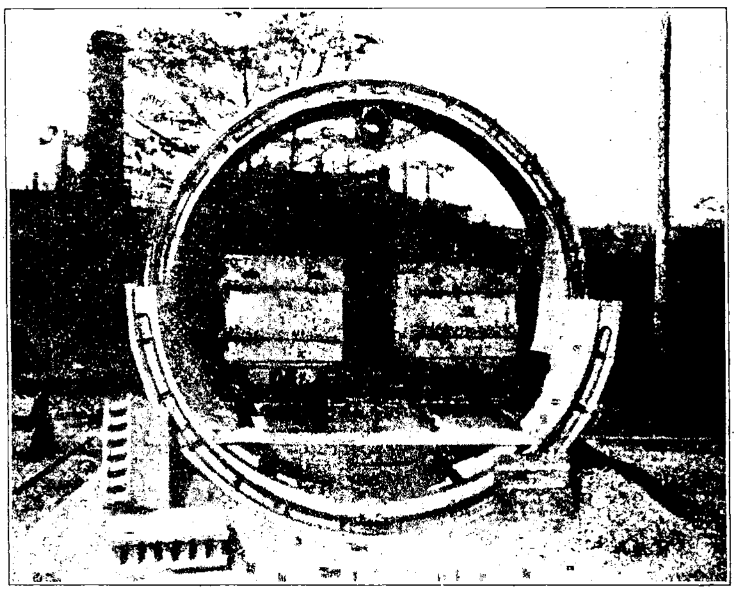

FIG. 3.—SEGMENTAL BLOCKS OF CONCRETE FOR LINING SHAFTS AND GALLERIES.

economical. Such a method was used in the main shaft of the Thurcroft colliery in England. A shaft about 650 meters (2,133 ft.) deep lined in this manner was inspected at Radbod, Germany; the segments were about 12 in. thick and were grooved to receive the ½-in. diameter reinforcement.

One of the most interesting mines was that at Marles, in the Pas de Calais District in France, where a shaft which had been in use for some time had caved in. The shaft was abandoned and remained in disuse for a number of years. When the speaker visited this mine they had begun to excavate the material including the head works which had caved in leaving a very large hole in the ground. The method of procedure was to build first a reinforced concrete frame 28 meters (about 92 ft.) square on top of the ground spanning this hole, attached to which were long rods for supporting the concrete lining of the new shaft which is about 18 ft. in diameter. The soil was intermixed with quicksand and saturated with water and was quite difficult to handle. The cementation process was resorted to, to stiffen this soil sufficiently to enable them to sink the concrete lined shaft. As the excavation proceeded the form suspended by the reinforced concrete frame was lowered and then horizontal holes were drilled leading from the shaft into the soil. These extended for a considerable distance into the soil and into these holes cement grout was forced under pressure; after an interval of time, to permit the soil intermixed with the cement to harden, the earth was excavated and the form was lowered; about 575 ft. of the lining had been constructed in this manner at the time of the speaker's visit and he understood that the shaft had to go at least 1,300 ft. before the coal was reached.

In the cementation process radial holes are drilled in the ground in which the shaft is being sunk for the introduction of the cement grout; Fig. 4 gives an idea of how the grout is forced through these holes into the soil to be cemented. It is frequently necessary to use very high pressure and experience shows that the greater number of holes drilled, the more effective is the process. The rate of hardening of the cement also forms an important item in the successful use of this process. The process has also been successfully used for increasing the bearing power of the soil for the foundations of structures.

At the bottom of the shafts there is the main entry gallery and frequently there are auxiliary entry galleries between this and the surface. The main gallery is almost universally of a permanent character, built chiefly of masonry; although there is a decided tendency to use concrete and one may see many galleries in which it has been used.

The galleries or mine entries differ in design, which is determined by local conditions. In order to secure maximum overhead clearance steel I beams are frequently used in the roof and the space between them filled with concrete; the side walls are of brick,

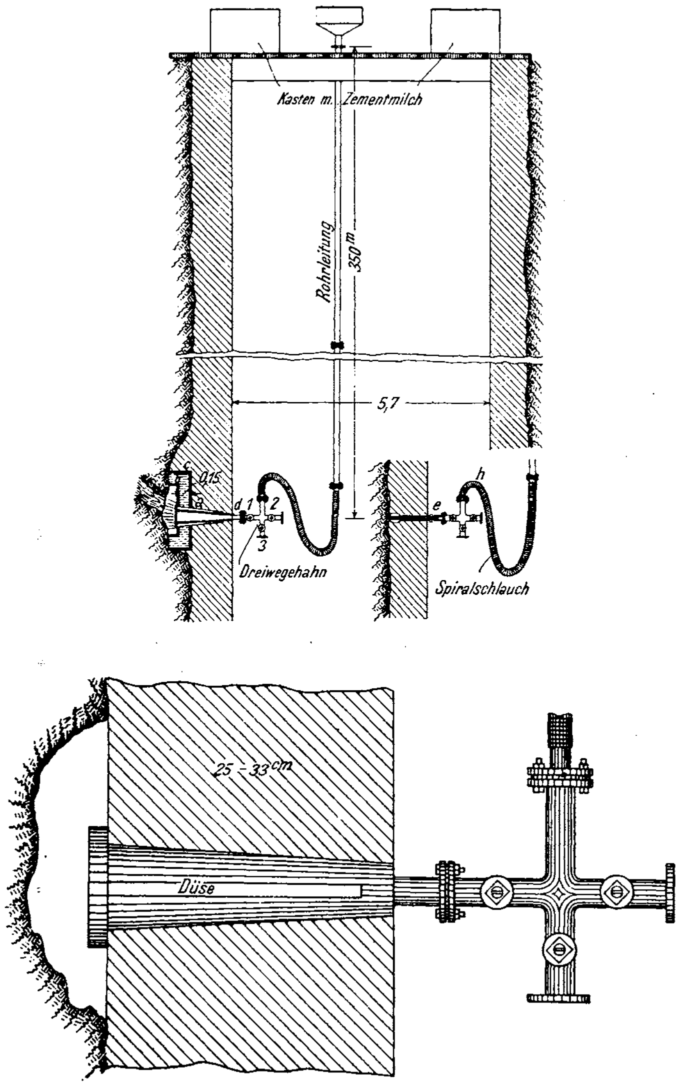

FIG. 4.—METHOD OF GROUTING IN THE LINING OF SHAFTS OR IN THE CEMENTATION PROCESS.

stone or concrete. Another method is to form an arch of corrugated metal, and fill the space between this and the roof, including the side walls, with concrete. Still another method shown in Fig. 5 is to form the walls and roof of concrete, which is the most satisfactory method. In some cases, where the mine is several thousand

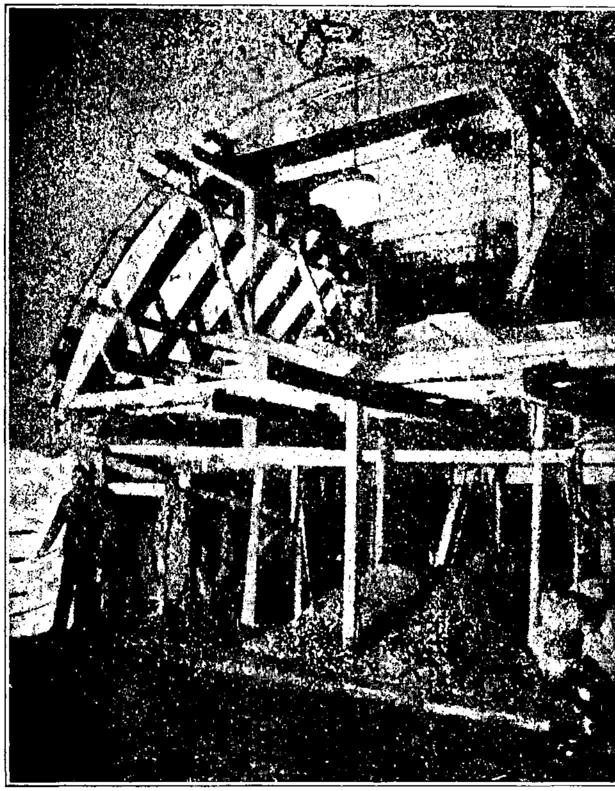

FIG. 5.—METHOD OF LINING WALLS AND ROOF WITH CONCRETE.

feet below the surface, the enormous pressure at this great depth necessitates unusual types of construction; it is found that where the floor of the gallery is not particularly hard, it constantly rises and the clearance in the gallery must be maintained by constant excavation. In such cases the type of construction shown in Fig. 6 is resorted to not only for the main but for the branch galleries also.

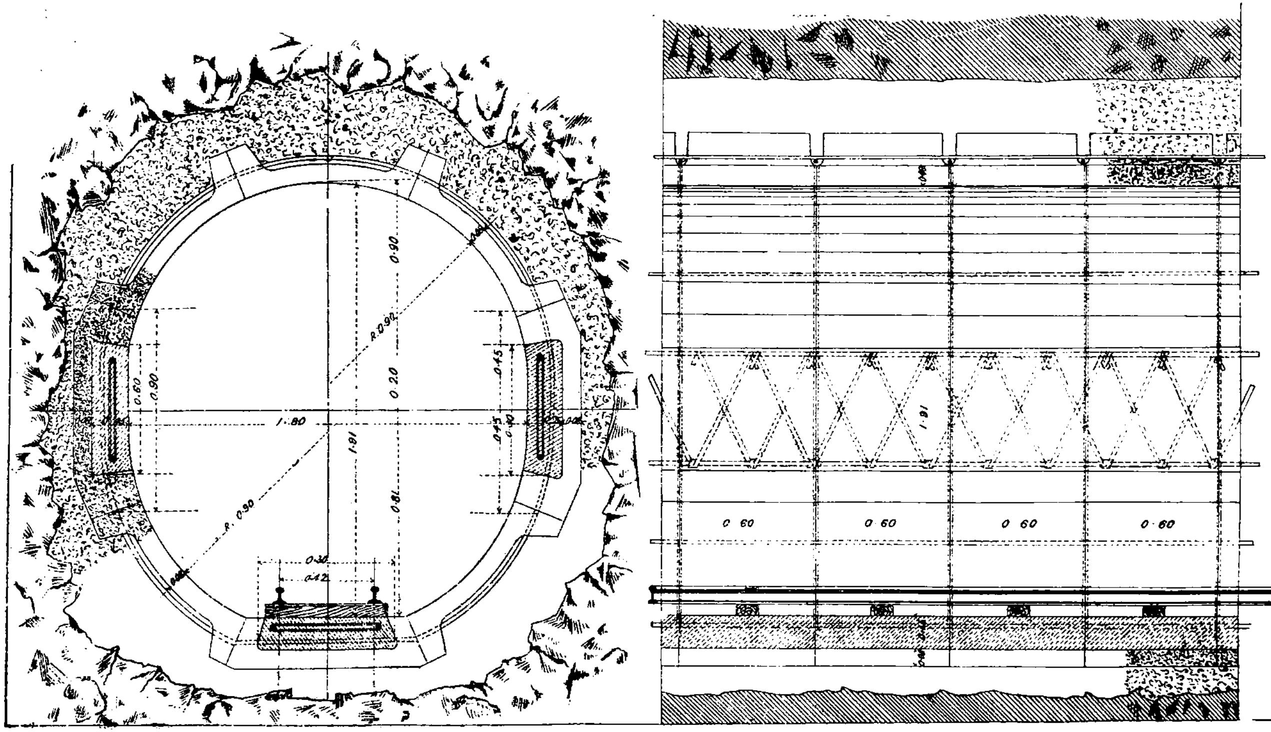

FIG. 6.—METHOD OF LINING GALLERIES WITH REINFORCED CONCRETE, AT MACHIENNE COLLIERY, CHARLEROI, BELGIUM.

This application of reinforced concrete is in the Machienne Colliery, Charleroi, Belgium; this colliery is said to be the deepest in the world (about 3,900 ft.) and the pressure on the lining of the gallery is very great. It is highly probable that no more economical or efficient material than concrete could be used under these conditions.

Fig. 7 is of interest because it illustrates a modern trend in shaft and gallery linings; this is a view of a cement products yard at Hibbing, Minnesota, for casting the separately molded

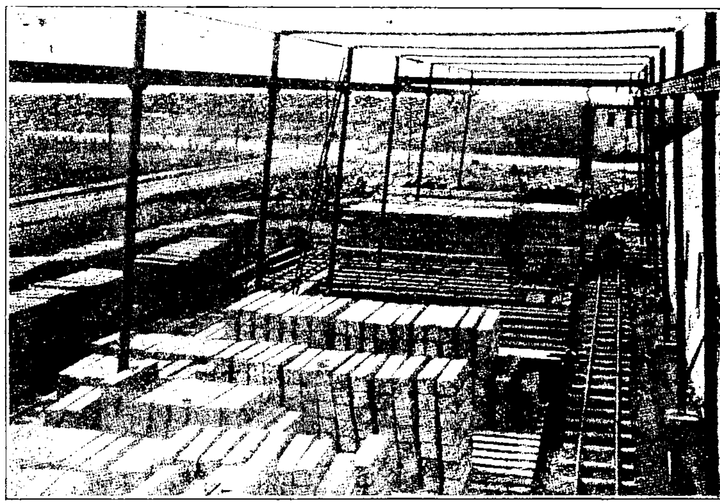

FIG. 7.—CEMENT PRODUCTS PLANT, FOR MAKING CONCRETE MEMBERS FOR LINING MINE SHAFTS, AT HIBBING, MINNESOTA.

members for such linings. In Fig. 8 may be seen an inclined shaft lining constructed of separately molded concrete members by the Ahmeek Mining Company, Michigan.

In several mines visited in Germany the circular gallery was in use, built after the manner of reinforced concrete pipe. This type is necessary in deep mines where the pressure is very great or where roof and floor are very bad.

Where coal is actually mined, the problem becomes more difficult; in the deeper mines in Germany it is impossible to find any type of prop which will withstand these enormous pressures.

The speaker frequently saw steel props buckled up like pieces of wire and wooden props crushed in the manner shown in Fig. 9. Under such conditions ordinary timber is insufficient and steel has not much greater efficiency. Resort has been had to reinforced concrete props with considerable success; although by reason of the weight of these props they have proven somewhat difficult to handle; if the floor of the mine is yielding there is a tendency for the prop of any material to punch through, but less so in the case of the reinforced concrete prop. This permits settlement of the roof and necessitates constant excavation in order to maintain the clearance necessary for the movement of the mine cars. Where

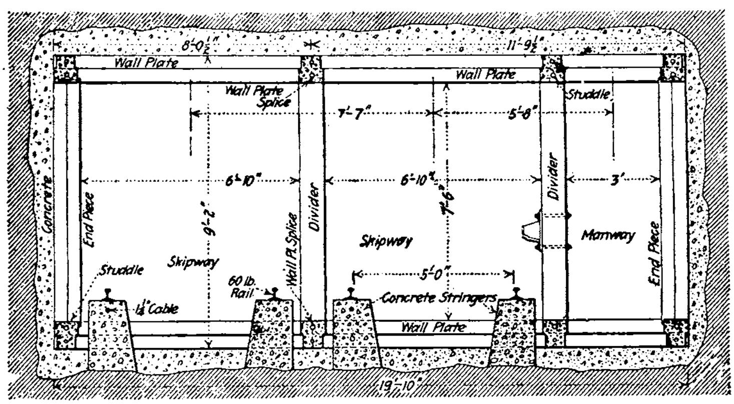

FIG. 8.—INCLINED SHAFT LINING IN WHICH SEPARATELY MOLDED MEMBERS OF CONCRETE WERE USED, AHMEEK MINING COMPANY, MICHIGAN.

reinforced concrete props have been used they have been found to be economical and durable.

In many cases, however, the construction of a reinforced concrete ring has been resorted to as the most economical method. Where the floor of the mine is of such poor quality that it is forced up under pressure, the props sink into it and it is almost impossible to secure a firm footing for the props. In some instances where the roof is good and the floor bad, it is only necessary to form an arched bottom in order to successfully meet the difficulty. The speaker recalls one mine in Germany at Dortmund where a horseshoe-shaped gallery lining of concrete, not particularly

FIG. 9.—MANNER OF FAILURE OF WOODEN MINE PROPS.

well reinforced, had been badly crushed under such conditions, and in extensions to this gallery a circular reinforced concrete lining was used.

One frequently finds underground stables and similar structures built of reinforced concrete, which is an admirable material for any underground structure because it offers the greatest resistance to fire of any of the available materials of construction.

At the top of the shaft is located the machinery for raising and lowering the mine cars. These structures have usually been built

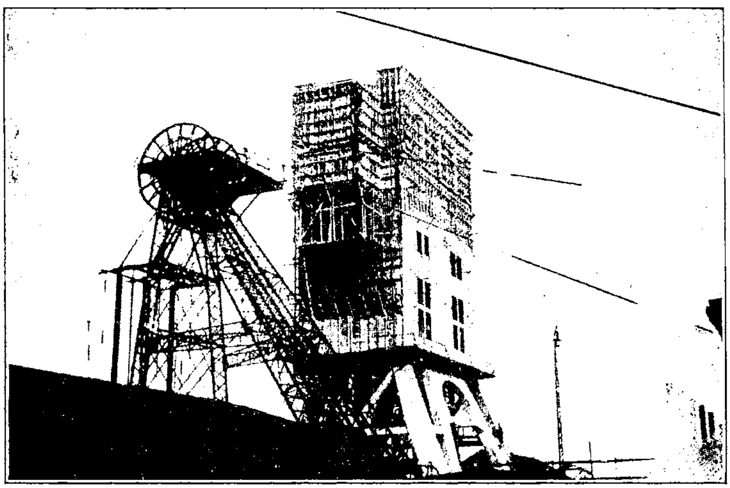

FIG. 10.—REINFORCED CONCRETE HEAD HOUSE AT CAMPHAUSEN, GERMANY.

of structural steel, but because of rigidity, durability and economy in cost of construction and maintenance, reinforced concrete is coming into general use and is proving eminently satisfactory.

Fig. 10 is such a structure erected at Camphausen, Germany; in this structure an electric motor-driven drum, carrying the cable by which the mine cars are raised and lowered in the shaft, is located in the upper part, the lower part being completely free of obstruction. The speaker was informed that the cost of this structure was materially less than steel and that it has proved thoroughly satisfactory. The structure shown in Fig. 11 is located at the colliery at Heapstead, England; in this picture may be seen a frame of reinforced concrete carrying the head house and a reinforced concrete stairway leading to one of the buildings.

A disastrous fire, destroying the coal breaker and other mine top structures will frequently shut down the mine for considerable time. When the lost profit on business thus interrupted is taken into consideration, the cost of reinforced concrete construction proves very much less expensive than the cost of any other material

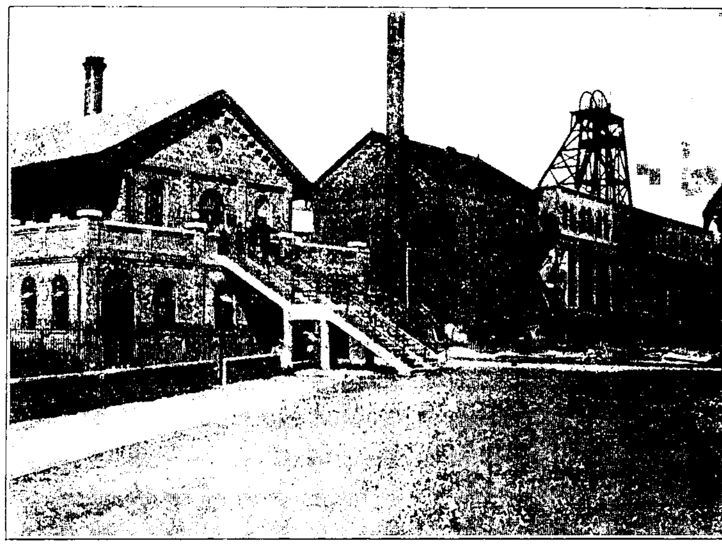

FIG. 11.—REINFORCED CONCRETE USED IN COLLIERY HEAD WORKS, HEAPSTEAD, ENGLAND.

because of its high fire resistance; such construction is frequently very little if any more expensive than the usual timber structure.

A most interesting example of this use of reinforced concrete is the breaker house shown in Fig. 12 erected by the Delaware, Lackawanna and Western Railroad, to replace the timber breaker destroyed by fire known as the Taylor Coal Breaker,* which the speaker is informed cost little more than that of a breaker of wood.

Fig. 13 is a coal storage bin erected in Germany, and illustrates a very common use of reinforced concrete.

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* *Proceedings*, Vol. VII, p. 371.

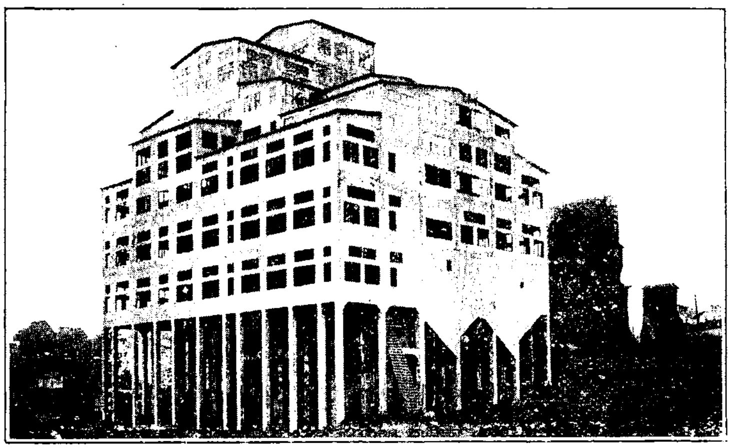

FIG. 12.—REINFORCED CONCRETE COAL BREAKER OF DELAWARE, LACKAWANNA AND WESTERN RAILROAD.

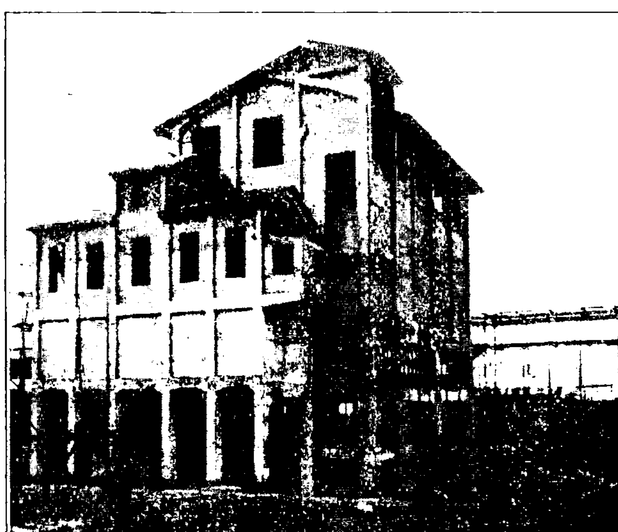

FIG. 13.—COAL STORAGE BIN AT COLLIERY IN GERMANY.

The use of reinforced concrete on the Continent for the construction of wash rooms for the miners, for engine buildings and

FIG. 14.—REINFORCED CONCRETE SETTLING TANK, SILVERWOOD COLLIERIES, ROTHERHAM, ENGLAND.

other structures, is very general and some very pleasing ornamental buildings are to be seen. These structures are kept in most excellent condition and there is not the appearance of dilapidation so commonly seen about the mines in this country; a further commendable practice is the removal of rubbish, so that the vicinity of the mine presents an orderly, business-like appearance.

The washery shown in Fig. 14 is that used in connection with the Silverwood Collieries, Rotherham, England. A number of similar tanks have been successfully installed at other collieries. The water from the washery, heavily charged with coal dust, is pumped into the tank and settles and the clear water is returned to the washery. The coal dust removed is used with the coal that is briquetted.

A structure of extraordinary interest to the speaker was that which is shown in Fig. 15 (Plate I); this is an articulated structure of reinforced concrete built on the unit system; it is located at the mine at Floreffe, Belgium. At the left may be seen the entrance to the mine and at the right the coal tipple. This structure was built of separately molded members, which were allowed to harden and were then assembled. The arch spanning the brook is three hinged and the manner of testing it with one of the test loads on it may be seen in the picture. The structure was erected with extraordinary speed and cost a great deal less than would a structure of any other material.

Another structure that was most interesting was the explosive test gallery of reinforced concrete built at Lievin near Lens in the Pas de Calais district. This gallery is 65 meters long, 1.85 meters high and 1.50 meters wide. The use of concrete in connection with a similar gallery at the U. S. Bureau of Mines is also worthy of note.

It is evident, the speaker thinks, that the use of concrete in mines will in the future be much more rapid and extensive than in the past; the use of concrete members separately molded as a substitute for timber, and segmental linings of concrete for shafts, tunnels and galleries, will meet with rapidly increasing favor.

The permanence of concrete construction, its low first cost and cost of maintenance, in addition to its plastic properties by which it may be readily formed into structures designed to satisfactorily resist the stresses covering widely varying conditions of use, are all elements which render concrete one of the most desirable materials for use in mine operations. The speaker is of the opinion that as the mine operator uses concrete and reinforced concrete he will acquire greater confidence and with this confidence will come a much greater application. It is certainly a most promising field for exploitation and it is hoped that the Association may be a medium by which the use of this material for this purpose may be greatly increased.

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THE USE OF CONCRETE IN HYDRAULIC WORKS.

Annual Address by the President,

Richard L. Humphrey.*

The speaker has received during the past year a number of requests from various parts of the country for information relative to the durability of concrete in both fresh and sea water. It would seem desirable, therefore, to discuss in this address the use of concrete in hydraulic works, with special reference to its durability. The speaker's first experience in the use of concrete in hydraulic works was in the construction of the concrete bulkhead along the Delaware River, Philadelphia, Pa., in the early nineties. It has been his good fortune to inspect the important structures of concrete not only in this country but in Europe and also those testing laboratories in which special investigations are being conducted as to the effect of sea water upon concrete. This information has been further supplemented by the experience gained in the investigations conducted at Atlantic City, N. J., while the speaker was in charge of the investigations of structural materials for the United States Government.

The construction of canals and waterways extends back several thousand years before the Christian era, although the use of cement in such structures began with the introduction of the

* Consulting Engineer, Philadelphia, Pa.

canal lock. Notable examples of the early use of cement are the Roman aqueducts, a number of which are still used in supplying water to the City of Rome.

The material used in the construction of these ancient structures was little better than hydraulic lime; that used in the Roman structures was a mechanical mixture of the volcanic ash or tufa from Pozzuoli near Rome, and slaked lime, corresponding to the slag cement manufactured in this country from granulated basic blast furnace slag and slaked lime. These structures in which this particular binding material was used were for the most part of masonry. The production of Portland cement came about through the search for a suitable material which would harden under water, for use in rebuilding the Eddystone lighthouse off the English coast. In the earlier works, concrete was used in large masses, the binding material was a hydraulic lime and later a natural hydraulic cement. The development of our modern waterways with an increasing demand for economy in connection therewith has led to an almost exclusive use of concrete and reinforced concrete for locks, dams and other structures.

This progress has been so rapid that today the almost indispensable qualities of this plastic material, which lends itself with economy to all forms of construction, has resulted in works which otherwise would have been impossible. In many parts of the country where stone and other building materials are not available, the materials for concrete are usually available. This is particularly the case in the reclamation of arid land by the United States Government where many structures have been possible because of the availability of concrete materials through whose use there has resulted not only economy in construction but also great reduction in cost of maintenance on account of its permanency and durability.

A large proportion of the enormous annual production of Portland cement is used in hydraulic works. This application of cement can be best discussed by illustrating the principal structures both in fresh and sea water and pointing out for each the advantages of concrete.

The early uses of concrete in this country in hydraulic works was in connection with the construction of canals, where it was used in the masonry walls of the locks and other similar work.

Natural cements were used for this purpose and a number of natural cement plants were established in various parts of the country, the purpose being to supply the cement needed in the construction of these canals; the first cement was produced in connection with the Erie Canal in 1818. The Potomac Canal, now the Chesapeake and Ohio Canal, is one of the earlier canals and in its history George Washington's name is very much interwoven in various capacities in connection with its construction and management. Following this first application of concrete it was used in harbor work. Some of the earlier attempts show a rather amazing conservatism in the crude application. In all of these structures concrete was used in mass and it is only in the last few years that the much more economical and efficient use of reinforced concrete has been attempted. At the present time there seems to be no limit to the application of concrete in all sorts of structures for hydraulic works, not only in fresh but in sea water.

In this application of concrete, the United States engineer officers have been pioneers, since the improvements of the rivers and harbors of this country by the Government are under their direction.

So many canals have been built in this country in which concrete has been used in the construction of the locks and dams that it would be impossible within the limits of this address to describe in detail each application. Only the most notable of these canals will be referred to, the first being one of International character, viz. the Panama Canal, in which upwards of five million cubic yards of concrete have been used in the construction of its locks and dams. Even assuming that there was sufficient suitable material available for the construction of these works of masonry, the time required for the completion of the canal and the cost of its construction would have been enormously increased had it been necessary to use stone masonry instead of concrete. The saving of millions of dollars in actual construction is probably not so important as the speed with which the canal was completed through the use of concrete. The various applications of concrete in the construction of this canal were fully described in a paper by S. B. Williamson.*

* See *Proceedings*, Vol. VIII, p. 326.

The illustration given (Fig. 1) is a view of the Pedro Miguel Locks during construction and illustrates the magnitude of these great locks and the various methods of construction, but is also illustrative of the magnitude of all the work along this canal. The collapsible steel centers used in construction of the conduits,—the wood forms for constructing the lock walls and the mechanical devices for handling the concrete, may all be seen in this view. The handling of concrete on the Panama Canal, involving such enormous quantities, reached a greater development than has been attained in any other work in this country. The mixers were not only very large but the quantity of the material handled each day was so extraordinarily large that the economical management of the plant was of prime importance. In connection with

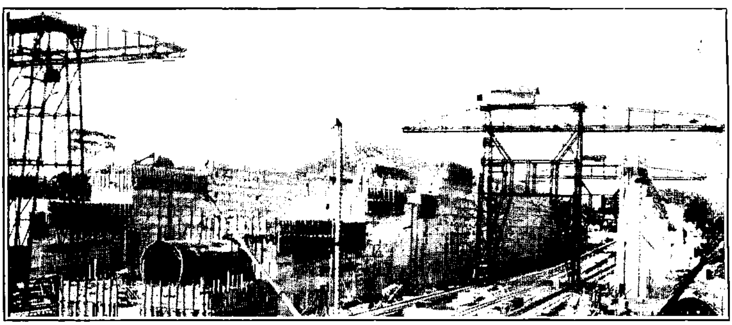


FIG. 1.—PEDRO MIGUEL LOCKS, LOOKING NORTH FROM EAST BANK.

the Gatun Locks an automatic railway carried the material from the storage bins to the mixers, from which the concrete was discharged into buckets which were conveyed by train to a point where cranes or overhead cables could move the bucket to the point where the concrete was being placed.

Next in importance to the Panama Canal is the New York State Barge Canal, which, although not as long or as wide as the Panama Canal, is of much greater extent and requires, therefore, a much larger quantity of material in its construction. It is perhaps not given the prominence it deserves because it is constructed under the auspices of a state and not of the United States and so is not of International importance.

Portland cement concrete is being largely if not entirely used in its construction. The various works of this canal are of the character which will be illustrated in connection with other works and they will not, therefore, be described in detail. The use of concrete in this canal was described by Russell S. Greenman.* The extensive use of concrete in the head gates, dams, and other structures has shown that without this material the cost would have been greatly increased and the speed materially decreased.

In the operation of the canal the most important portions of the structure are the locks. In the earlier canals of this country

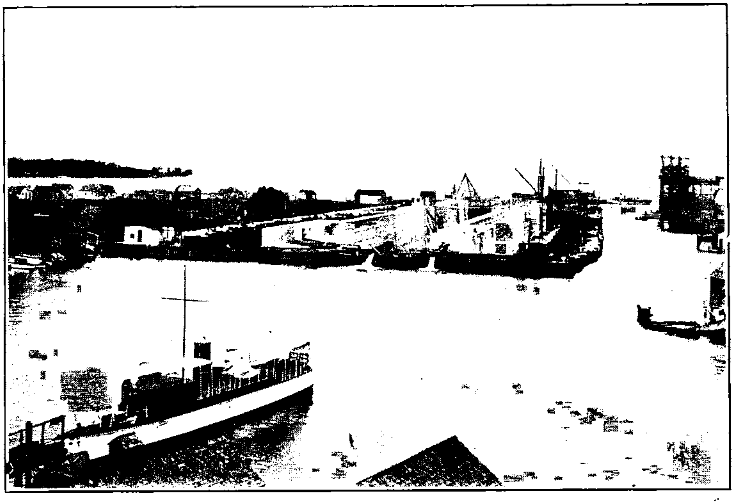


FIG. 2.—CONCRETE SHIP LOCK AT BLACK ROCK HARBOR, NEW YORK.

the walls of these locks were of masonry laid in natural cement mortar and later laid in Portland cement mortar. Now these locks are built entirely of concrete, thereby increasing the facility and speed with which they may be constructed and largely decreasing the cost. Perhaps one of the most interesting locks is that shown in Fig. 2, built in connection with the ship canal in Black Rock Harbor near Buffalo. A coffer dam completely surrounds the locks, the massive walls of which were constructed of concrete, without interference with the river traffic.

* See *Proceedings*, Vol. VI, p. 196.

In the operation of canals it is necessary to erect dams and other controlling works to so regulate the flood waters of the river that the required depth in the canal may be maintained. Numerous controlling works of this nature are to be found throughout the country, the type of the construction being dependent upon local conditions; concrete lends itself admirably as a plastic material to the wide diversity of forms which these structures must have. As an illustration of the use of concrete in the construction of dams it is almost impossible to decide on the view to take. The Shoshone Dam, forming a part of the United States irrigation project in Wyoming, was built in an almost inaccessible

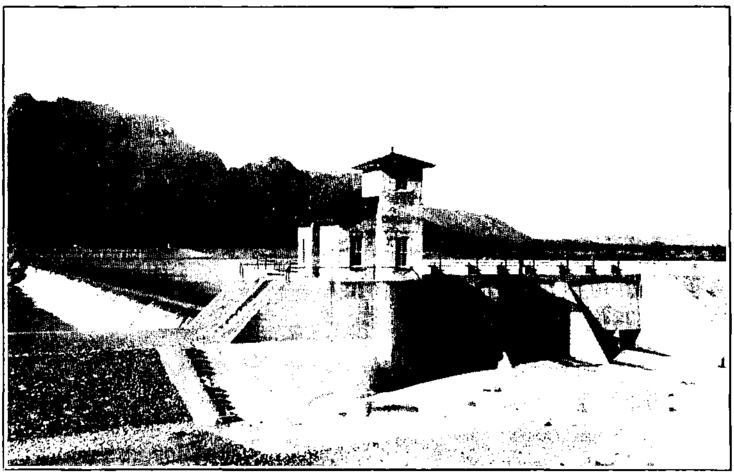


FIG. 3.—GRANITE REEF DAM, ARIZONA.

canyon, of concrete composed of the crushed granite obtained from the red granite walls between which the dam was constructed. The dam is one of the highest in the world and forms a lake extending for a distance of 12 miles back from its crest. Many of the dams of the New York State Barge Canal and the Panama Canal are much larger, but not one is so picturesque.

The Reclamation Service has many interesting structures which serve as monuments to the engineering skill of this branch of the United States Goverment. The value of concrete in the construction of these works cannot be overestimated. In many parts of the territory covered by this work the inaccessibility and lack of the materials of construction other than sand, crushed stone or gravel has made concrete the only available material. Fig. 3 is a view of the Granite Reef Dam, Arizona, one of the many controlling dams for impounding the water used for irrigation purposes.

One of the important features of irrigation work is the dis-

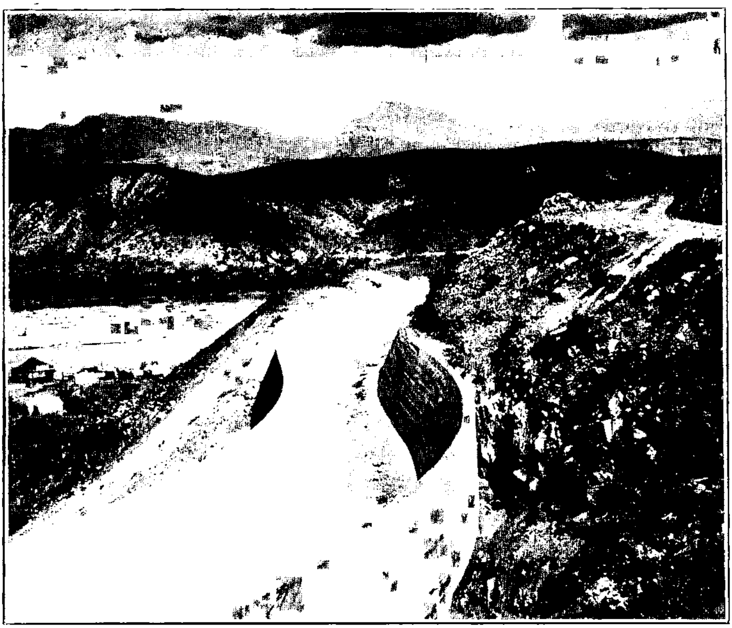


FIG. 4.—A PORTION OF THE CONCRETE-LINED POWER CANAL NEAR ROOSEVELT, ARIZONA.

tribution of the water from the impounding reservoirs through the various main and branch canals to the land to be irrigated. It is essential that little of this water shall be lost in transit and a study has been made of the losses which result from leakage, evaporation and other causes. It is, therefore, frequently necessary to line the canals with concrete in order to prevent ground leakage, while in some projects the water is carried in covered conduits to prevent the great loss by evaporation in this arid land.

Fig. 4 shows a portion of the concrete-lined power canal near Roosevelt, Arizona. It will be noted that part of this lining outside the cut becomes a retaining wall.

It is frequently necessary to carry the canal over a ravine, in which case concrete is an admirable material for the construction of these viaducts, not only as to economy in the cost of structure but also as to its water-tightness, which is illustrated by the view of aqueduct 8 on the line of the Illinois and Mississippi Canal (Fig. 5).

The Reclamation Service has a number of plants for the manu-

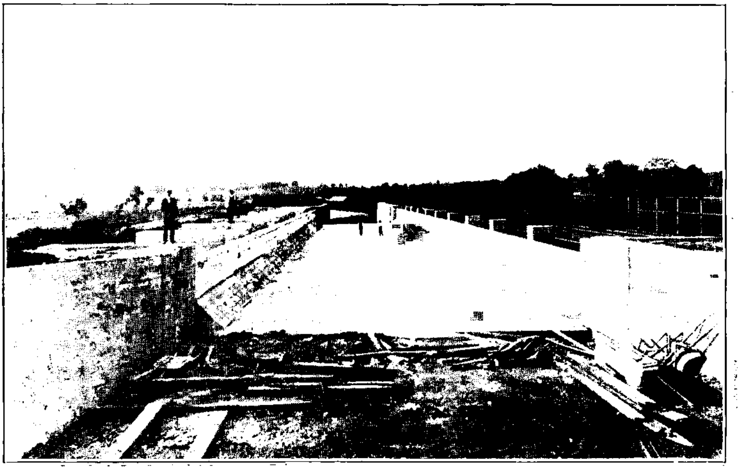


FIG. 5.—AQUEDUCT NO. 8 AND LOCK NO. 27, ILLINOIS AND MISSISSIPPI CANAL.

facture of reinforced concrete pressure pipe used in the distribution of water; this pipe can be manufactured and placed for very much less money than cast iron pipe, and there is a saving not only in the cost of manufacture but of the cost of transportation of cast iron pipe. Another type of pressure pipe is illustrated by the reinforced concrete conduit 5 ft. $3\frac{1}{2}$ in. in diameter on Simm's Creek, Sun River Project, Wyoming, which was built continuously in place.

A striking example of the adaptability of concrete to unusual forms of construction is illustrated by the view (Fig. 6) of the main Tieton Canal in the Tieton Canyon, Yakima Project, Washington. The rapid fall of the Tieton River is such that it is impossible to place a concrete lining in the canal and it became necessary, therefore, to form the sections of the canal, and after they had properly hardened they were transported and placed in position as shown.

In connection with water power development concrete again proves itself to be a material of unequalled value. The construction of the main shafts and conduits and other works connected with water power development can all be advantageously

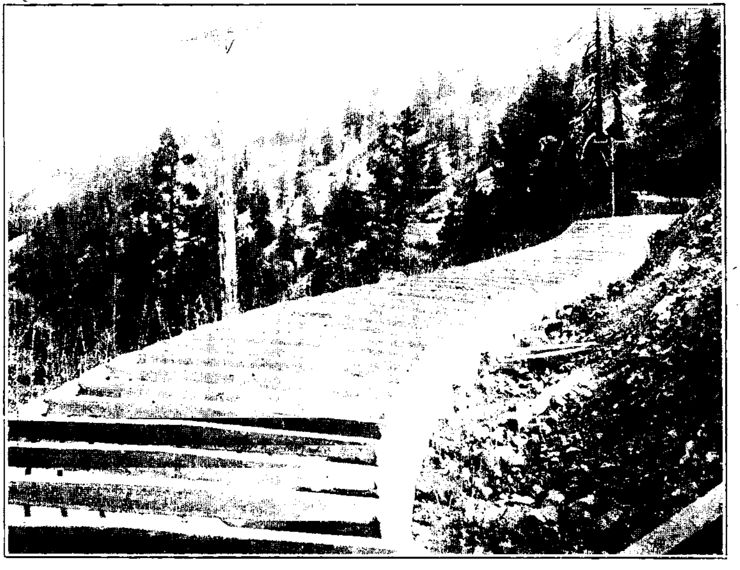


FIG. 6.—MAIN TIETON CANAL, YAKIMA PROJECT, WASHINGTON.

constructed with concrete and almost always at a considerable saving in the cost. The view (Fig. 7) is the main conduit of reinforced concrete of the Canadian Niagara Power Company.

The earliest use of concrete was in harbor improvements in which it was used in construction of quay walls, piers, docks, and other structures. The speaker was connected with the initial construction of the bulkhead (Fig. 8) along Delaware Avenue in the City of Philadelphia in 1897, in which the saving in the cost and the permanency of the structure proved concrete to be one of the most economical materials. This wall was constructed by placing 90-ton blocks of concrete on a mattress filled with mortar resting on the top of piles and casting the walls of concrete in place above the high water line, as shown in the illustration. This wall is over 16 years old and has proved satisfactory in every way.

Another purpose for which concrete has proved to be indispensable is in the construction of breakwaters, of which there are many types. The method of construction varies with the location. Some are constructed by placing the concrete in forms;

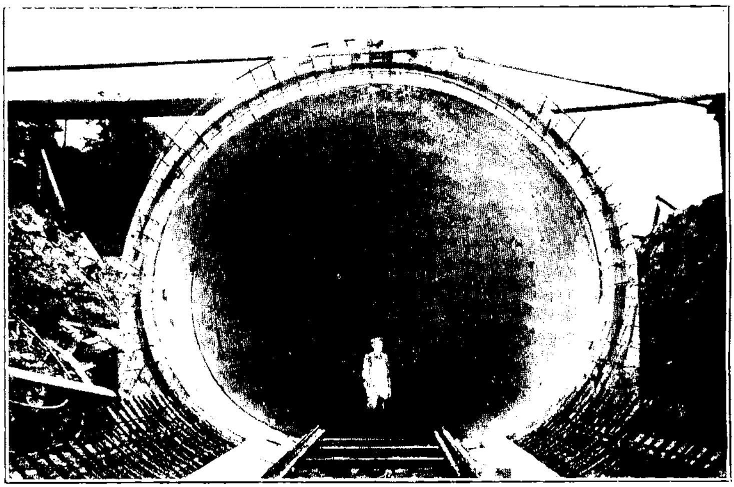


FIG. 7.—REINFORCED CONCRETE CONDUIT, CANADIAN NIAGARA POWER COMPANY.

in others it is composed of large blocks of concrete, molded on land and allowed to harden before being so placed as to form a solid mass; while in others, smaller blocks are so placed as to form pockets which are filled with gravel, stone or other similar material, the whole extending above high water line and upon which is cast a solid coping of concrete; and still another type (Fig. 9), proposed by Major Judson of the Corps of Engineers, U. S. A., consists of building on land caissons of reinforced concrete, which are allowed to harden and are then launched and floated over their final resting place and sunk by filling with water, sand, gravel or broken stone. Generally a lean concrete is placed about 4 feet thick as a base for the coping.

The use of reinforced concrete caissons for breakwaters and bulkheads is rapidly growing and is extending to various parts of the world. These caissons prove of great value in the construction of lighthouses where the exposure to wave action is such as to render the erection of any structure difficult. The caissons can be floated to the desired locality and sunk into position; they possess decided advantages as to economy in construction,

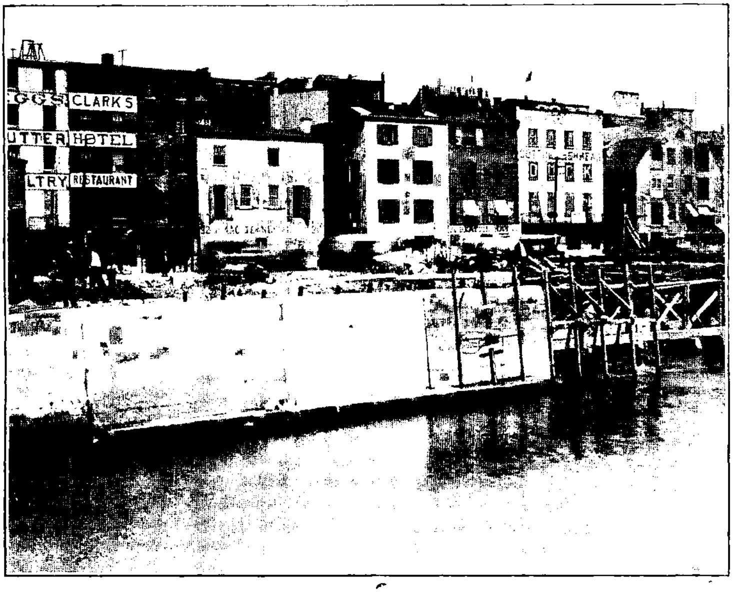


FIG. 8.—CONCRETE BULKHEAD ALONG DELAWARE AVENUE, PHILADELPHIA, PA.

and durability; and their stiffness and substantial character make them practicable for towing for considerable distance regardless of the condition of the sea. In view of the rising cost of timber and its short life under conditions of exposure to sea water, it is evident that this type of construction will be increasingly used in the future.

Fig. 10 is a breakwater consisting of molded blocks forming compartments which have been filled with gravel upon which a solid concrete coping has been placed.

In the protection of shores from the scour either of the sea or of the river, concrete again proves invaluable. One of the most notable uses of concrete in connection with sea exposures is the Galveston sea wall which was erected immediately following the disastrous flood which destroyed the greater part of this unfortunate city. Through the construction of the Breakwater at Galveston the city was protected against damage from future floods; the toe of the wall is protected by granite blocks and the top

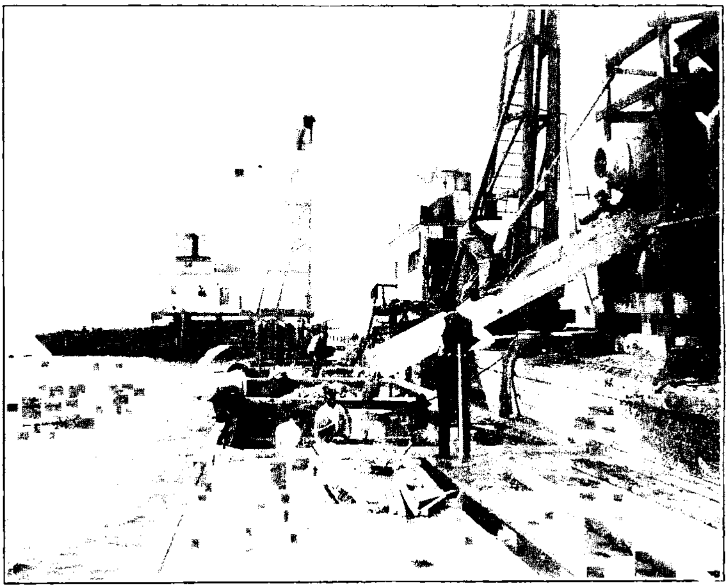


FIG. 9.—FILLING REINFORCED CONCRETE CAISSON WITH LEAN CONCRETE, ALGOMA HARBOR, WISCONSIN.

raises the level of the city several feet above high tide and has proved to be a magnificent barrier against the sea.

Another barrier to prevent erosion of earth embankments is that constructed along the Little Miami Bottoms in the vicinity of Cincinnati, Ohio. This reinforced concrete slab covers and protects the mud embankment of Beechmont Avenue across the Little Miami Bottoms from the scour of the floods in the Miami River. It is about one mile long, 10 to 15 ft. high and 5 in. thick.

Fig. 11 is another interesting structure devised by Major Shultz of the United States Engineer Corps. It is a reinforced concrete dike constructed at St. Joseph, Mo. These dikes are usually built of timber, but their lack of stability and durability has led to their construction of reinforced concrete, for the reason that this type of dike is more substantial and durable, the cost of repairs is reduced to a minimum and in many cases its first cost is less than that of timber.

In the construction of piers and wharves, concrete again proves to be the most suitable material. These structures for

FIG. 10.—BREAKWATER AT BUFFALO, N. Y., SHOWING MANNER OF CONSTRUCTION.

the most part are built on wooden piles and because of the short life of the piles have proved expensive not only as to first cost but as to maintenance; this is particularly true on the Pacific coast where the life of the piles is extremely short because of the destructive limnoria and teredo. The reinforced concrete pile has, therefore, come into increasing favor as a substitute for wooden piles. In many cases economies can be effected by reason of the fact that fewer piles can be used and the concrete slab can be placed directly on the tops of the piles at a considerable saving in the cost. The advantage of this pile as to permanence and cost of maintenance cannot be overestimated. These structures of concrete are generally found to be less costly than timber construction besides having the additional saving in the decreased cost of maintenance. A great variety of piles are manufactured. Some are molded on land and when sufficiently hardened are driven or jettied into position; others are formed by driving a metal cylinder or shell where the pile is required which is then filled with concrete, and still others are made by driving a metal cylinder or shell which is withdrawn and the hole left in the ground filled with concrete as the shell is withdrawn. Again, hollow cylinders

FIG. 11.—REINFORCED CONCRETE DIKE AT ST. JOSEPH, MISSOURI.

of reinforced concrete are molded and when properly hardened are placed in position, the water pumped out and the interior filled with concrete.

Fig. 12 shows the support for pier No. 8 built by the Bureau of Yards and Docks at the Navy Yard at Puget Sound, Washington. The method of construction consists in building hollow cylinders of reinforced concrete having an enlarged base, which are placed in position and filled with gravel, stone or concrete and upon which the structural supports of the pier of reinforced concrete are constructed. The view shows these cylinders in position with the projecting reinforcement around which the reinforced concrete beams and girders of the deck of the pier are cast.

Similar wooden hollow cylinders were used in the construction of the wharf at Fort Mason, San Francisco, California. In this case the wooden cylinder was placed in position, filled with concrete and the shell was removed after the concrete had properly hardened. Upon these concrete pillars the superstructure of reinforced concrete was placed.

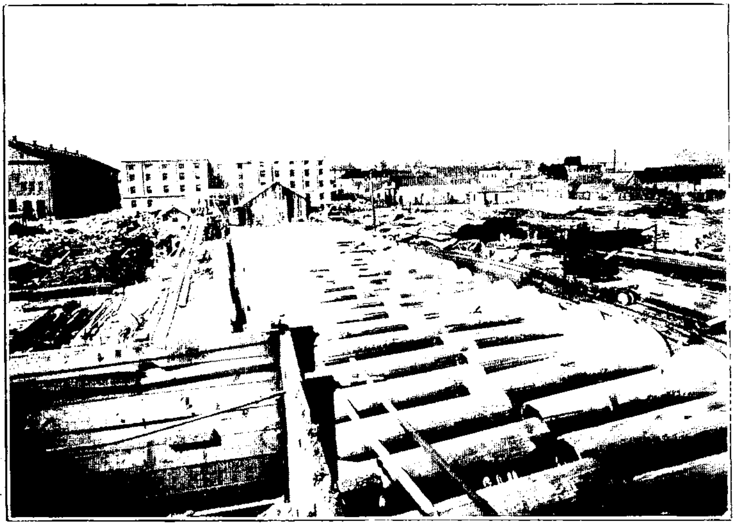


FIG. 12.—REINFORCED CONCRETE PILE SHELLS FOR PIER 8, NAVY YARD, PUGET SOUND, WASHINGTON.

Another use of concrete for timber work exposed to sea water, is to encase the pile or timber with a jacket of reinforced concrete and thus protect it against the limnoria, teredo or rot.

Fig. 13 is a view of the reinforced concrete sheathing used in the harbor improvements at Baltimore, Md. This sheathing was cast on land and after it was properly hardened was driven and formed a tight bulkhead because of the tongues and grooves in the sheathing. A feature about reinforced concrete piles is that they may be driven with very much heavier hammers than are commonly used for wooden piles, and when properly cushioned they stand such driving without crushing or otherwise becoming defective. One notable instance of the severe treatment which these piles are likely to receive is the quay wall which rests on a coral reef, built by the Hennebique Construction Company, at the Navy Yard, Key West, Florida. The frequent occurrence of an intermediate crust of coral rock made it necessary to puncture this in order that the pile might have a solid bearing on the coral reef. This crust was frequently mistaken for the coral reef and

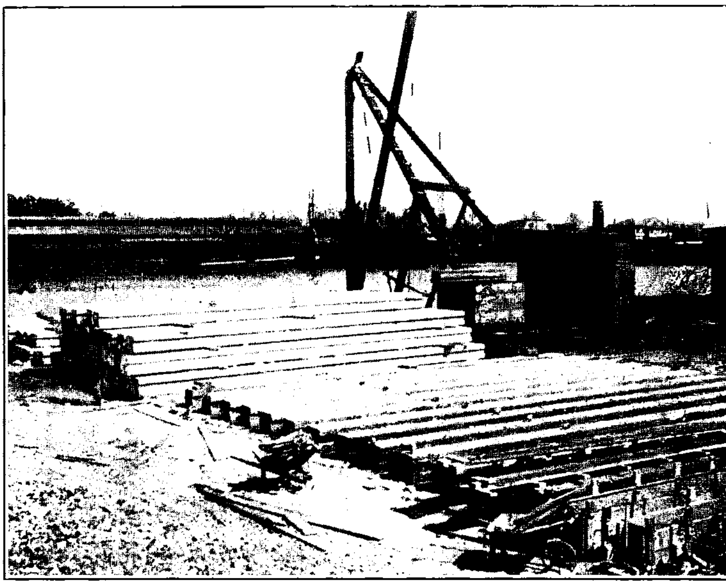


FIG. 13.—MOLDING YARD FOR REINFORCED CONCRETE SHEET PILING, BALTIMORE, MARYLAND.

in trying to drive through this the pile was broken. These piles were provided with hoops at the butt and a cast iron shoe at the point.

The proved economy in the cost and the durability have fully demonstrated the value of the reinforced concrete pile and it is gradually supplanting the wooden pile.

Reinforced concrete piles can be built to almost any length, certainly to lengths upwards of 60 ft. and in these lengths they are much more economical than wooden piles.

Another interesting use of concrete is in the construction of drydocks of which there are a number in this country. The constructors, however, seem to think it necessary to go to the additional expense of either facing the entire drydock with stone (usually granite), or at least facing the walls at the entrance and at the water line. This is an unnecessary expense as concrete

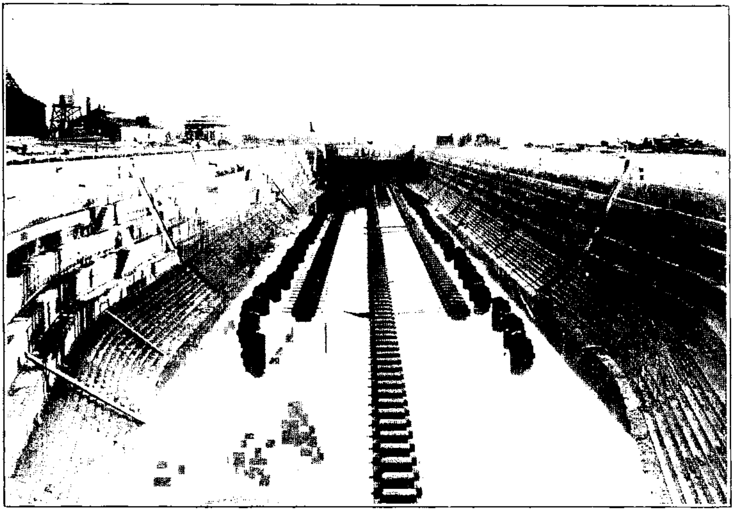


FIG. 14.—CONCRETE DRY DOCK, LEAGUE ISLAND NAVY YARD, PHILADELPHIA, PENNSYLVANIA.

can be used for the construction of the entire drydock at a great saving in cost over stone and with a minimum cost for maintenance. The dry dock at the League Island Navy Yard, Philadelphia, Pa. (Fig. 14), is constructed entirely of concrete.

By reason of the great difficulty of constructing lighthouses which must necessarily be at greatly exposed places, concrete has proved again to be invaluable. Many of the lighthouses built by the United States Lighthouse Board are entirely of concrete. Some consist of heavy cast iron cylinders filled with concrete. A growing practice, however, seems to be to construct a base with a pneumatic caisson of wood and build a central pier, of 20 or more feet in diameter, upon which the lighthouse is built; or to form this base in a caisson similar to that described in Fig. 11. Such caissons can be built on shore and can be towed to the site, loaded with broken stone or gravel until they settle into the desired position; on this caisson as a base the lighthouse is built. This is also true in the construction of breakwaters.

Concrete, to properly withstand the action of sea water, should be allowed to harden before it is subjectd to the sea water. Where the structure is constructed in the open sea, this is almost impossible and it is, therefore, necessary to protect it against the sea. The difficulty of constructing concrete work in the sea, where it is subjected to tides and storms under conditions by which it is completely submerged, is easily understood and it would seem desirable that such structures should be built, whenever possible, of blocks of concrete molded on land and allowed to properly harden before being placed in position.

A great deal has been said concerning the disintegration of concrete in water, especially sea water. In fresh water the disintegration is the result of frost action and takes place between the tides. This is likely to occur where the concrete is porous and is lacking in density. With concrete properly mixed and hardened, and of the requisite density, there is little or no damage from frost. In sea water this is equally true. It was formerly the general practice throughout the world to mix concrete quite dry, *i. e.* so that the water would just flush to the surface under continued tamping. Permeable structures resulted, which permitted the surrounding wat er to penetrate to the interior of the mass, especially in that portion between the tides, where there was danger of disintegration from frost action.

The speaker has inspected structures of concrete in various parts of the world, has visited the principal laboratories in which studies are being made of the effect of sea water or alkalies on concrete, and has also been identified with the United States Government Experiments carried on under his direction at the United States Geological Survey laboratory at Atlantic City, N. J. It is his opinion that it is perfectly practicable to build structures of concrete or reinforced concrete both in fresh and alkaline water that will not be damaged in any way by the action of frost, sea water or other alkalies.

The view (Fig. 15) of Pier No. 1 of the United States Navy Yard at Boston, Mass., shows clearly the effect of properly and improperly mixed and placed concrete. Rear-Admiral Richard C. Hollyday was in charge of the Boston Yard at the time this pier was constructed in 1901–1902 and he informed the speaker that the two portions were by different contractors. The outer end was built by Miller and Ellis in 1901, and the shore end by Norcross Brothers in 1902, the same material having been used in both portions. The concrete in Norcross Brothers' end was mixed fairly wet, while that built by Miller and Ellis was dry

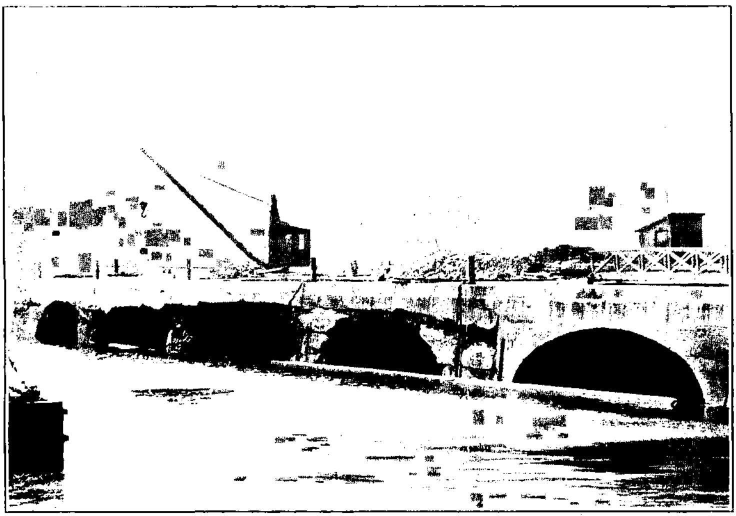


FIG. 15.—PIER NO. 1, NAVY YARD, BOSTON, MASSACHUSETTS.

concrete of a leaner mix. The resistance between tides of the two concretes is evident, that on the right side of the picture being unaffected while the other is badly disintegrated; the submerged portions of both were practically undamaged. The lesson taught by this experience is that well proportioned, dense concrete will withstand the action of sea water where lean, dry mixed concrete will fail. Inasmuch as many of the earlier structures were built of dry mixtures, the resulting permeable concrete has shown the effect of frost between tides. The speaker has found in his investigations that almost universally the disintegration of concrete takes place between high and low water, and has never found an instance of the disintegration of submerged properly proportioned dense concrete. It has also been his experience in the tropical waters where there is no frost action, that concrete of reasonable density is unaffected. After disintegration of the concrete has started through frost action, there is undoubtedly some chemical action of the sea water on the concrete. The speaker has never found an authenticated instance where concrete had disintegrated from the chemical action unless it had been permeated by sea water before it had set.

In the states of Wyoming, Montana, and the Dakotas, what is known as the Black Alkali District, where the soil is inpregnated with this alkali, disintegration of concrete has occurred at the ground water line. The ground water is drawn up by capillary action and the rapid evaporation of this water and consequent rapid crystallization in the pores of the mass destroys the bond, and results in complete disintegration. Under these conditions, stone and brick and other building materials are similarly affected. This is notably so in the vicinity of Great Falls, Montana, where stone buildings, brick sewers and similar masonry structures are largely destroyed by this action.

An important matter in the erection of reinforced concrete buildings in salt air is the proper protection of the reinforcement for the reason that the corrosion of the improperly imbedded metal may result in serious damage to the structure. At Atlantic City, N. J., one of the large piers has been seriously damaged because of the use of a porous aggregate which permitted moisture and air to reach the reinforcement and the corrosion of this has stripped the concrete from it. The aggregates, therefore, under such conditions should be hard and dense and so proportioned as to secure a concrete of maximum density.

In conclusion, it would seem evident from the examples cited that concrete lends itself to a great variety of structures in both fresh and sea water and has proved to be one of the most economical and durable materials. It is, of course, necessary to observe the necessary precautions pertaining to the use of concrete, more so in sea water than in fresh water; there is no question that there are numerous structures that have successfully resisted the action of sea water. On this point attention is called to the interesting sea water experiments conducted by French engineers at Cristobal, Panama, in 1886. These tests consisted in exposing large cubes of concrete, of various proportions and compositions, to the action of sea water. The blocks were placed on the shores of the Atlantic Ocean at Cristobal where they have been since tossed by the waves for nearly thirty years. While their edges have been slightly rounded, these blocks of concrete are still perfectly hard and show no evidence of softening or disintegrating.

Some interesting experiments are being conducted by the Aberthaw Construction Company in the Boston Navy Yard; long prisms of concrete composed of various materials and mixed in varying proportions have been exposed for a number of years to the action of sea water and the results thus far indicate that when it is properly mixed and placed concrete is unaffected by sea water.

Its great durability, increasing in hardness with age, and its freedom from necessity of repair, makes concrete one of the most valuable of the materials of construction from the point of economy as regards the cost and the maintenance of the structure in which it is used. The speaker's visits to the various laboratories of Europe and the results of the tests conducted by himself and others, lead him to the opinion that where concrete is properly proportioned, mixed and placed so that the resulting mass is of maximum density, it affords ample resistance to the action of both fresh and sea water, especially if sufficient time is given the concrete to harden before its subjection to this action; and he is further of the opinion that good practice demands that concrete shall be mixed a sufficient length of time, without too much water, so that there results a mass of viscous consistency which will flow readily and in which the ingredients will not separate. Increased mixing of concrete develops colloids and results in a sticky, viscous, dense, impervious mass, which will shed water and produce a concrete of maximum strength and resistance to the action of both fresh and sea water.

The increasing use of concrete both with and without reinforcement and the testimony of the many excellent structures already in existence lead to the conclusion that because of the intrinsic merits of this material it is the most suited and the best adapted of the materials of construction for use in hydraulic works.

THE PROGRESS OF A DECADE.

ANNUAL ADDRESS OF THE PRESIDENT.

By RICHARD L. HUMPHREY.*

The marvelous increase in the use of Portland cement during the first decade of the life of this organization has exceeded the dreams of the most optimistic members present at the time of its formation. The use of concrete has developed amid bitter opposition, criticism and abuse to the honored position of one of the most important materials of construction. What the next decade will bring forth no optimist among us today can possibly foresee, for great as has been the development in the last decade, the next decade will undoubtedly show that our knowledge and application of concrete at the present time is as crude and limited as it was at the time this organization came into existence. This transition, from a period where most conservative constructors were content to allow others to acquire experience in the use of concrete and reinforced concrete (and these materials were first used by such progressive pioneers as had the courage of their convictions and the foresight to recognize possibilities), to the present time covers one of the most remarkable periods of development in the history of building materials; more particularly will this be true of the next decade, when the constructor has acquired such confidence in this remarkable material as to no longer use it in imitation of other materials, but instead as a plastic material which readily lends itself to varied conditions of use, either for structural or for ornamental purposes. Its well-established qualities for ornamental purposes need no comment; the speaker has had the honor to bring to the attention of this Institute the possibilities of concrete from an artistic point of view, in describing some of the beautiful structures to be found abroad and pointing out the increasing number of such structures in this country.

* Consulting Engineer, Philadelphia, Pa.

The excellent fire resistive qualities of concrete which have resulted in an increasing popularity for fire proofing purposes, emphasized by each successive fire, alone establish it as one of the important materials of construction. Unfortunately, the constructor, in his conservatism, seems to go beyond the bounds of common sense and reason and expects concrete to possess, in measured degree, qualities which are expected of no other material. The Edison fire is an exemplification of its fire resistive qualities. The critics who view the reinforced concrete buildings that withstood so satisfactorily the extraordinary conditions surrounding this fire, look at the damage done to concrete and in so doing lose their bearings; they fail utterly to consider, first, that no other material could have given so excellent an account of itself as concrete, and, second, that no material is fire proof, as its fire resistance is only relative. No material can resist a fire of sufficiently great intensity or duration. Critics view with complacency the complete wreck of brick wood-joisted structures and of all buildings other than those of concrete. The marvel in the behavior of these buildings of concrete is not that they were damaged, but that they should have withstood the extraordinary conditions so well.

The past decade has probably been the most critical in the history of the cement industry, and there is no member capable of fully realizing the vital importance of the part this Institute has played in its development. Its educational work, its conventions, its expositions, and particularly its committee work in preparing recommended practice and standard specifications, have guided the use of cement along safe and practical lines and assured the permanency of the construction in which this material is used. It is only necessary to go abroad to appreciate how very much the European organizations watch and follow the recommendations of this Institute; for America and the American Concrete Institute are today in the very forefront as exponents of the possibilities of concrete. The European constructor, as the speaker has pointed out in previous addresses, is more advanced in that he has a better conception of the possibilities of concrete than has the constructor in this country, because the former thinks of it as a plastic material, so designs the structure in which it is used and does not attempt to imitate other building materials.

The use of a binding material for masonry structures extends back to early Biblical days, and the use of some form of lime to Roman antiquity. The development of the present hydraulic binding material from the ordinary fat limes, puzzuolana cements, hydraulic limes and cements, is of great interest. We attribute the durability of Roman and other structures several thousand years old to the remarkable qualities of the binding material used in their construction, failing to realize that these structures of concrete in and about Rome have survived, in a favorable climate, and that the induration of the mortar is the result of centuries. How much of this early concrete was destroyed even under these favorable conditions is difficult to say. It was the supposed superiority of this binding material that led the early investigators of the eighteenth century to seek to recover a supposed lost Roman art.

"Necessity is the mother of invention," and so the modern Portland cement resulted from the necessity for a cement, which would harden properly under water, for use in rebuilding the Eddystone Lighthouse. The use of reinforced concrete had its birth in the latter part of the eighteenth century with a gradual development during the nineteenth, which reached its present great development during the twentieth century. The production of Portland cement was 26,505,881 barrels for 1904 and 88,514,000 for 1914, or 3,000,000 less than for the previous year. These ten years coincident with the life of this organization cover a decade of the greatest activity in the use of cement in the history of the industry. Considering the extraordinary circumstances which mark the progress of events during 1914, viz., the inauguration of new governmental policies, affecting our life under a protective tariff, affecting our banking system, and affecting our railroads and other business organizations, and abroad of the greatest war of history—the consumption of Portland cement during the year was most remarkable, especially since the completion of the Panama Canal ended the annual consumption of approximately 1,000,000 barrels. The speaker is of the opinion that, in the near future, with an end to the period of retrenchment which has characterized the progress of business in this country since 1907, the repressed prosperity thus released will result in such an increased consumption of Portland cement as to bring the curve to the position of progressive increase it must have occupied had the business conditions remained normal.

As a result of this increase in production during the past decade, this country has become the largest producer of Portland cement in the world; our present production almost exceeds the combined production of all the other countries.

At no time in the history of the building industry has the constructor had at his disposal a cement possessing the unexcelled qualities of the American Portland cement.

The use of Portland cement in sidewalks in this country was as early as 1882, and at the time of the formation of this Institute the art was considerably developed and cement sidewalks, having outlived the objections to them, were in general use and were generally acknowledged to be the most desirable. There was, however, a great diversity of opinion as to the proper method of construction, and many bad sidewalks were laid through ignorance as to correct methods. One of the first committees appointed by this organization was that on Sidewalks and the Proceedings of the earlier years are filled with interesting discussions by sidewalk constructors, showing considerable diversity of practice in different parts of the country. This discussion and interchange of views as to the correct practice resulted in the present standard specifications of this Institute, which are universally accepted; it is rare now that one finds a bad sidewalk being laid, and when one does it is generally being laid by an inexperienced constructor.

As has been previously pointed out the need of a cement for use in the masonry of locks and other structures connected with canals led to the establishment of a plant for its manufacture in the State of New York in 1818. The development of the use of this material in connection not only with canals but hydraulic works has been quite remarkable. The speaker last year pointed out the wide diversity of structures in which this material was being used, which was justification for the statement that its use for this purpose was practically unlimited and that it has proved itself to be one of the most desirable materials for the construction of hydraulic work. The greatest and most important application of this material was in the Panama Canal, actively started and built during the existence of this Institute. It is fair to state that concrete made possible the efficient construction of this canal; through its use the cost was greatly reduced and the time of construction materially lessened.

There are a number of examples of the early use of concrete in the construction of sewers, some of which are more than thirty years old. However, concrete was not used to any great extent for this purpose until after this organization was formed. Experience has led to decreased cost and increased skill in making dense, impervious pipe, and has resulted in its successful introduction in municipalities; in this use we are far behind the foreign manufacturers because cement sewer pipe is much more extensively used throughout Germany and other foreign countries. A paper to be read before this Convention, describing the use of cement sewer pipe in the City of Philadelphia, shows the great possibilities for this type of construction. Philadelphia has used concrete in its larger sewers for many years but has been using other materials in its smaller sewers; the experience which has proved concrete to be the most satisfactory and the cost of installation to be only two-thirds of that for brick, assures for it a pre-eminent rank for all kind of sewer construction.

Cement pipe has come into general use for drainage and irrigation purposes; many members of this Institute are engaged in its manufacture and there has been much discussion at our conventions as to proper methods of manufacture and the tests to which it should be subjected; the first manufacture of cement drain tile by power machinery was in a small factory in Iowa, in 1905; the industry now produces over a quarter of a million lineal feet, representing nearly ten million dollars. There is no doubt that cement drain tile is more durable than other tile and generally less expensive.

At the time of the birth of this organization the use of reinforced concrete in buildings was limited; only a few large buildings had been constructed and there was considerable doubt as to its value for this purpose; at present there are a very great number of reinforced concrete buildings and they are no longer regarded with curiosity and suspicion but are proved to be most desirable as regards first cost, low cost for upkeep, and resistence to fire. The report of the Committee on Insurance several years ago stated that of the several hundred buildings reported on twenty-five per cent of the owners did not think it was necessary to carry insurance on the building but only on its contents.

The use of concrete for bridges extends back many years previous to the formation of this Institute. It was, however, during the existence of this Institute that some of the very best examples of the art were built, both in this country and abroad. This Institute has undoubtedly been a potent factor in stimulating the artistic treatment of concrete and the speaker is very glad to state that there are increasing numbers of artistic structures being erected in this country; they fully equal those structures abroad which he has had occasion to illustrate in his several annual addresses. There is probably no material today so well adapted for bridge construction as concrete, since it fulfills three essential requirements; first, economy in the initial cost; second, low cost, and generally no cost, for maintenance, and third, the possession of those plastic qualities which readily lend themselves to any design. In our permanent highways which are now rapidly developing, reinforced concrete bridges will be very generally used. In railroad work, particularly in Western lines, concrete is one of the most valuable materials available. The ability to gather locally all the material required (except the cement and reinforcement), has made possible many structures at very low cost; beside it has eliminated the necessity of maintenance which is generally a matter of considerable importance to these railroads. Even in Eastern railroads, concrete, because of its permanency, is replacing structures of other materials; in the City of Philadelphia may be found some recent examples of the use of concrete in railroad work, notably where the Pennsylvania Railroad crosses the Schuylkill River and Broad Street, which exemplify its artistic qualities and in my opinion mark the beginning of a much more extensive application. The Broad Street girder bridge, which girders are usually built of steel and unattractive, is, through the use of concrete, rendered inconspicuous since the embellishment of this bridge in concrete is pleasing to the eye and entirely attractive.

In the removal of grade crossings in the City of Chicago the development of the flat slab type of construction and innumerable other applications of concrete have given during the last few years an extraordinary impetus to the use of concrete in this field of construction.

In the works of the Reclamation Service in the far West concrete has again proved of extraordinary value in the isolated localities in which most of these structures must be erected; it is said many of these could not have been built except through the use of concrete. It is certain that the amount of money expended by the Reclamation Service in the construction of its important works has been very materially reduced, and they have been completed in much less time through the use of this material.

During the earlier conventions of this Association the speaker pointed out the value of concrete for roadways, and his endorsement of this use of concrete was met with skeptical comment. No one cared to express a favorable opinion, but it was evident that all present thought that such views were altruistic. His opinion, repeated at subsequent conventions, led to a similar feeling, and one of the daily technical papers in the report of the sixth convention, stated that "President Humphrey seems to be a firm believer in cement as a road material. If it does not work out right, it is the fault of the workman," and in the report of the seventh convention remarked, "President Humphrey still believes in concrete roads."

TABLE 1.—SHOWING GROWTH IN CONSUMPTION OF PORTLAND CEMENT FOR CONCRETE ROADS.*

	Square yards.	Barrels of Cement.
Prior to 1909	862,880	
1909	416,460	104,000
1910	1,009,120	243,000
1911	2,014,740	513,000
1912	5,556,656	1,850,000
1913	8,576,160	2,880,000
1914	14,997,550†	4,499,000

In Table 1 it is shown that the development in the use of Portland cement for concrete roads beginning with a consumption of about 104,000 barrels in 1909, has reached the extraordinary consumption of nearly 5,000,000 barrels during the current year. The concrete road has proved most economical as to the first cost and maintenance, and most desirable from the point of service. The coming of the automobile has obliged us to consign our

* Compiled by the Association of American Portland Cement Manufacturers.
† Of this amount, 4,109,900 square yards were placed in city streets.

highly developed knowledge of the art of road construction, to the waste paper basket, and to apply ourselves to the development of a new roadway to meet the new conditions resulting from its introduction. It is in this field that concrete gives the best account of itself as to service and economy in cost of construction and maintenance. At the instigation of your President a Committee on Concrete Roadways was appointed in 1908, and it was with difficulty that a chairman was secured. The Institute specifications for concrete roadways are now the standard for this country, are followed closely abroad and experience in their use has demonstrated that they are the best available.

The Institute has been instrumental also in the development of concrete fence posts, telephone and telegraph poles. When the matter was first discussed before this body, people looked askance at the idea of making a fence post of concrete, not only with reference to its strength, but particularly with reference to its cost. The permanency of the post, its rigidity (which reduces greatly the cost of maintenance), and particularly the decrease in the cost of manufacture, has led to its rapid introduction; at the present time the cement post is no longer an experiment or a curiosity, for excellent examples of its use can be found in all parts of the country.

The telephone and telegraph pole is being gradually introduced. The discussion of these poles before this organization, its approval of them and the papers which have been presented describing where they have been successfully used, all indicate that their use will be much greater in the future than in the past.

It would be impossible within the limits of this address to describe the many activities of this Institute affecting the use of cement; but two more references will be given.

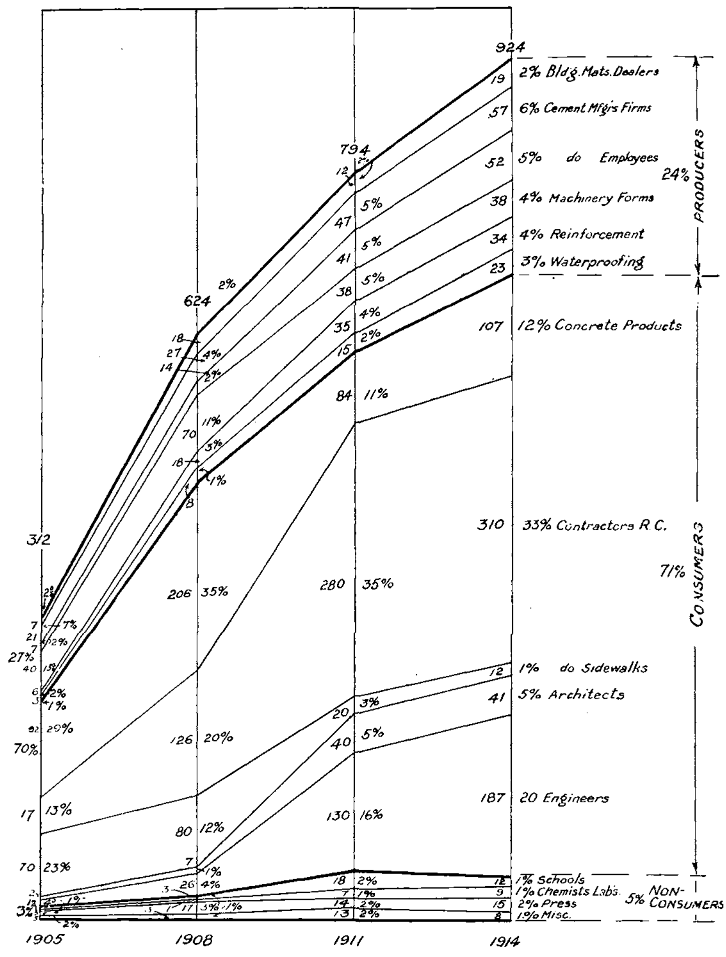
The speaker wishes to point out that some years ago reference was made to the reinforced concrete railroad tie, and when the matter was discussed he expressed the opinion that the reinforced concrete tie was the tie of the future. Little headway is being made in its development in this country. Numerous ties are in use, but the cost is high in comparison with their life, and particularly objectionable is the rigidity of the resultant roadbed which the motive power man considers detrimental to the equipment operated over it. There are, however, a number of reinforced concrete ties in successful use. Abroad—especially in Italy—the ties are being used in large quantities. In that country, where more than a half million ties are in use, the lack of a cheap wood or metal tie has increased the economy of the concrete tie; those who are interested in the development of the reinforced concrete railroad tie are directing their energies to so designing the reinforcement as to take up the stresses which come upon it and prevent failure which is usually by crushing along the inside of the rail. The introduction of an elastic cushion between the rail and the tie has resulted in a less rigid roadbed and has tended to absorb the shock of passing trains. The speaker is decidedly of the opinion that it will be only a short time before a thoroughly efficient tie will be developed, and the use of reinforced concrete railroad ties will be as extensive as is the present use of concrete for roads and other purposes.

The Institute, as will be shown later, has been very much handicapped for funds to carry on its work, and for this reason such investigative work as it has been able to do has been all the more commendable. Many committees have been conducting special investigations, but the most important is the Committee on Reinforced Concrete and Building Laws, which has contributed some of the most important information on the strength of reinforced concrete floors. Some of the first buildings in which floor load tests were efficiently applied were under the auspices of this committee, and the reports and discussions to be found in the Proceedings constitute the best available information on this subject. The Committee reports at this Convention one of the most important set of tests of reinforced concrete columns that has ever been made; a series of tests that will contribute much to the available information; the large size of these columns (commensurate with working conditions), gives to the results of these tests the same value as the results of the load tests applied to the reinforced concrete buildings.

Although this organization has produced more than eighteen standards and recommended practice, its work has only just begun. The existing standards must be revised, new ones developed, and there never was so much need for work of this character as at the present time. Permanency is the keynote of concrete and reinforced concrete; to secure this permanency, concrete must be properly and intelligently used, and the knowledge which will make this possible can only be secured through the development of standards embodying the latest experience in the use of the material. This Institute in its technical endeavors, a record of which is in the ten volumes of Proceeding which have been issued, has acquired a high standing and an honorable place among the technical societies of this country and Europe.

In describing the activities of the Institute for the past ten years it seems to the speaker only fair to place on record the story of how these accomplishments have been made possible. Few members of the Institute are aware of the character of its membership, of the value of the service rendered per member, of the income per member, and other vitally important matters which you entrust to your Board of Direction and which are briefly recounted in its annual reports.

This organization was started in 1905 as a result of the activity and foresight of the Cement Block Machinery Manufacturers. The primary purpose was to develop the use of the cement hollow building block along intelligent lines; this purpose was largely commercial. Because of the conditions surrounding its formation, the organization was called, after much discussion, the National Association of Cement Users. The speaker was summoned from his bed on January 19, 1905, at 3 o'clock in the morning, to the Columbia Club in Indianapolis, to a meeting of the organizing committee who were deadlocked over the selection of a representative of a commercial organization for President; at this meeting the speaker accepted the Presidency, which was unanimously offered to him without conditions, with no expectation that he would serve for more than one year. The development of this organization, which led to a change in its name to the American Concrete Institute, was not necessarily the result of a change in the character of its membership. Many in this country had a feeling that the National Association of Cement Users was a trade organization, and since this was entirely contrary to its real functions, it was deemed desirable to change the name to its present one, which is believed to more clearly typify its character and activities. Diagram No. 1 shows that even at the time of its organization, the consumers of cement were greatly in excess of the producers of the various materials and appliances required in connection with its use; this relationship has since changed until at the present time the users of cement constitute 76 per cent of its members, and the producers of cement, machin-



NO. 1.—CHARACTER OF MEMBERSHIP.

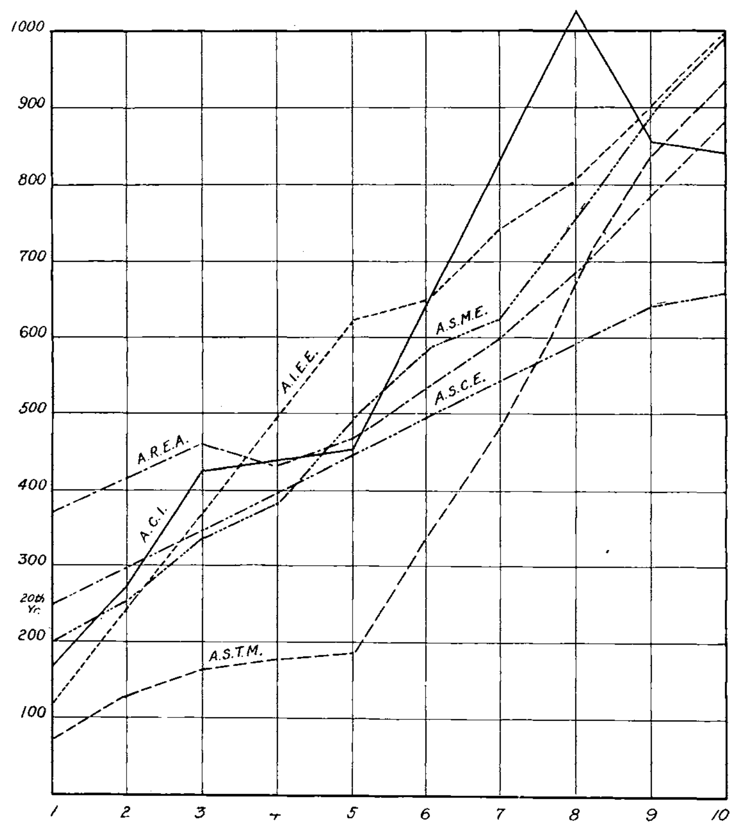
ery, reinforcement and other supplies constitute 24 per cent. This Institute is, therefore, a technical organization not dominated in any way by commercial interests; its work is educational, in developing correct practices and standard specifications and in disseminating a knowledge of the proper uses of cement. The Institute is a member of the American Society for Testing Materials and the National Fire Protection Association, and its representation on important committees of these societies has been most beneficial. The attitude of its representatives in not asking for more than a square deal, of being willing to recognize that reinforced concrete is not perfect and has its limitations, and insisting that it should be properly applied and used wherever possible, has been most helpful to the industry. The speaker thinks this organization may look with pride on the fact that in its ten years of existence it has never permitted itself or its members, at its Conventions or in its Proceedings, to assail any other building material, but has confined itself to an exposition of the merits of concrete. The speaker believes this attitude, and this course of procedure, has made many friends and has done much to further the rapid use of concrete.

The standards and recommended practice promulgated by this Institute have exerted a wide influence in the betterment of current practice in the use of cement. This influence has been reflected in building regulations in various portions of the country, in which have been incorporated many of the recommendations of this Institute.

The reports and papers presented before the annual conventions have received a wide publicity through their republication in the technical press both in this country and abroad, which has been productive of much good both from an educational and a commercial point of view in stimulating a proper use of cement.

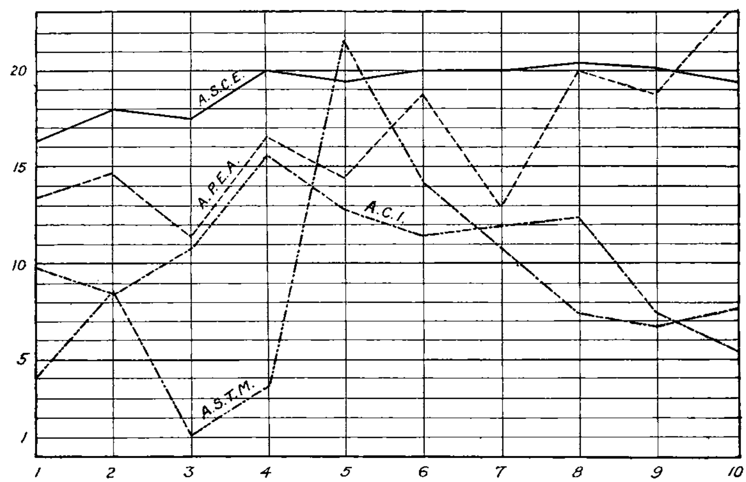
The Proceedings have permanently recorded the result of these deliberations, but the most important effect has been the interchange of practical experiences by those in attendance, not only on the floor of the convention, but during the convention. Those who recall the earlier conventions realize how eagerly these conventions were attended by those who sought the practical experience which was not to be acquired in any other way. During the decade covering ten conventions, 236 papers and 56 Committee Reports have been presented and make ten volumes of Proceedings, totaling 5,858 pages. The dues of the members have remained $5 a year, which have been returned to the members 'n the value of these Proceedings.

The Cement Show has been a most potent factor in popularizing the use of concrete; none can properly gage this influence. Hundreds of thousands of people not directly interested in



NO. 2.—GROWTH IN MEMBERSHIP.

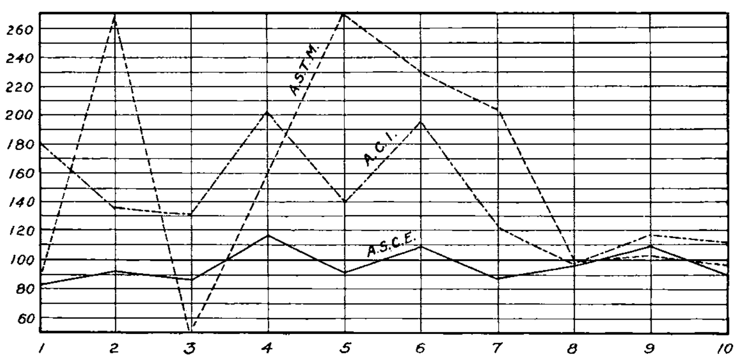
concrete have visited these shows and carried away ideas which have subsequently borne fruit in an increased use of cement. The First Cement Show was held under the auspices of the National Association of Cement Users and annually thereafter, until 1907, when by mutual agreement the Cement Products Exposition Company co-operated with this Institute in holding the annual Cement Show. It was never a desirable thing for a technical organization to manage a show which is in its very nature largely a commercial proposition; but in the pioneer days its work in this line was of the highest importance, and the Cement Show proved to be one of the most successful of the educational industrial expositions that have been undertaken. This Institute, therefore, can place to its credit the initiation and successful operation of the Cement Show for a sufficient number of years and on a sufficient scale to establish its ability in this direction.



NO. 3.—COST OF SERVICE PER MEMBER.

Diagram No. 2 shows the growth in membership of this Institute in comparison with some of the leading National Societies, attention being particularly directed to the fact that the curve for the American Society of Civil Engineers begins at the twentieth year. It is interesting to note that the American Society of Civil Engineers, which was organized in 1852, held only a few meetings, and after three years of existence, there succeeded a period of twelve years during which time no meetings were held; the records of membership begin at the twentieth year. From this diagram it is evident that the American Concrete Institute has shown for the first eight years a much more rapid growth than any other organization, and the members can view with pride the record of its achievement in this respect.

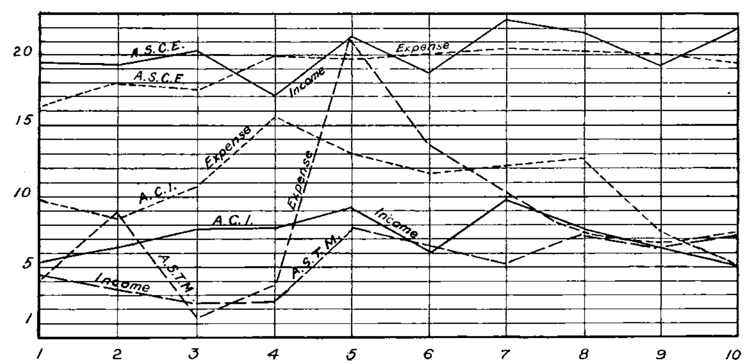
During the last two years the Institute has been mightily handicapped for funds, and it has not been possible to keep up the increased activity which would stimulate increase in membership. Indeed, under the strenuous conditions which have prevailed it has not been possible to carry on a campaign for membership for the reason that the funds were not available for this purpose. As a result of this enforced inactivity the number of members has decreased as shown in the diagram. As illustra-



NO. 4.—RATIO = $\frac{\text{EXPENSE.}}{\text{INCOME.}}$

tive of the situation, Diagram No. 3 is presented which shows the expense and income per member for the American Society of Civil Engineers and the American Society for Testing Materials, for which information is readily available. Both the American Society of Civil Engineers and the American Society for Testing Materials, are now self-sustaining, the former having accumulated a great surplus, which is annually increased about $30,000. From this diagram you will observe that during the earlier periods of the existence of the Institute the receipts were considerably less than the expenses. In Diagram No. 4 is shown the ratio of the expenditures to the receipts for each member, and it may be seen that the American Concrete Institute compares favorably with the other societies; that is, its management is fully equal to that of the other societies shown.

From Diagram No. 5 it is apparent that the expenses of the Institute are in excess of the dues and that these expenses are in excess of $10 per annum. The sale of the Proceedings, advertising and other sources of income, supplement these dues and reduce the deficit in the Institute funds. However, past experience has shown that the cost per member was in excess of $7 per annum and it was necessary to supplement the amount received from dues, by subscriptions, advertising and other means.



NO. 5.—INCOME AND EXPENSE PER MEMBER.

During the ten years the gross expenses of the Institute have exceeded $75,000. The revenue from dues has amounted to about $20,000. Exclusive of the over $17,000 special fund subscribed this year, there has been raised during this period $47,936.49, divided as follows:

Special contributions and subscriptions	$8,663.75
Sale of publications, advertisements, membership certificates	10,703.72
Contributing membership	2,540.00
Exhibition	18,747.27
Local subscriptions, account Convention	7,281.75
	$47,936.49

In other words, in the ten years during which the speaker has been President, over $63,000 has been obtained from sources other than the dues, for the support of the organization.

SUMMARY OF RECEIPTS AND EXPENDITURES OF THE AMERICAN CONCRETE INSTITUTE.

JANUARY, 1905, TO FEBRUARY 12, 1915.

RECEIPTS.

Dues	$19,431.94
Contributions and subscriptions	21,688.75
Sale of publications, advertisements and membership certificates	10,703.72
Convention	7,281.75
Exhibition	18,747.27
Miscellaneous	359.53
	$78,212.96
Unpaid subscriptions	4,425.00
	$82,637.96

EXPENDITURES.

Office Expenses:	
Salaries and rent	$18,474.83
Postage, printing, stationery, etc	7,320.35
Equipment	522.44
Miscellaneous expenses	1,607.50
Board of Direction and Committee expenses	1,854.44
Membership campaign	634.37
Publications, membership certificates, etc	22,706.62
Convention	7,664.95
Exhibition	10,395.79
Miscellaneous	2,118.67
Uncompleted publications	3,250.00
	$76,549.96

Your Board of Direction became convinced several years ago that an increase in the dues was highly desirable and it therefore recommended that they be increased to $10 per annum. As the matter did not meet with particular favor, there being a feeling that there were a large number of members who could not afford to pay $10 a year, whose membership would be lost through this increase, your Board canvassed the opinion of the membership by letter-ballot. The result of this is given in Table No. 2, and from which it may be seen that on this question the membership was nearly equally divided. Your Board, therefore, deemed it inexpedient to raise the dues at that time. The financial condition of the Institute, however, did not improve and it became necessary, therefore, to undertake some plan which would insure its future existence and growth. Accordingly it was decided during the current year to raise a fund to care for the deficit and provide a sufficient excess to enable it to carry on the work necessary to place it in a position where it would be self-sustaining. This plan contemplated the employment of a Secretary who could give his entire time to the work at an increased salary; the

TABLE 2.

Result of Letter-Ballot on Increase of Dues.

	Yes	No	Total
Manufacturers	38	21	59
Small users	43	51	94
Large contractors	30	30	60
Engineers	70	55	125
Architects	5	13	18
Miscellaneous	4	4	8
Press	5	1	6
	195	175	370

task of raising $12,088 by special subscriptions was entrusted to your President, through whose efforts over $17,000 has been subscribed, and at no time in the history of the Institute has it been in such a strong condition financially. Today all its obligations to its members have been fulfilled; its debts have been paid, and the incoming Board of Direction has available a surplus to meet the expenses of the current year. The speaker is now fully convinced—as are all those who have given the matter consideration—that the dues should be increased to $10 a year, since no national society can successfully exist on annual dues of $5 per annum.

It is felt that the American Concrete Institute now occupies a very important position in the cement industry; that it has more than justified the necessity for its existence and that it would be a calamity to permit it to lapse and possibly go out of existence from lack of adequate support. Everyone who is interested in the industry should become a member and thus give his support in the development of the industry. Such membership returns more than the value of the dues in the service rendered, but aside from this, each member should face the situation unselfishly and not measure the value of his membership by what he can secure for himself, but rather by his duty to the industry from which he obtains a livelihood. During the period when your officers were hopelessly trying to stretch the dues to cover the essential expenses, the organization and its expenditures were subjected to that critical analysis which always arises under such conditions: the fact that no substantial defect in its management could be found, and that the work done by the headquarters office was very much greater, and at a very much less cost per capita, than that of any other national society, is justification of the statement that the Board of Direction has done its best to successfully run the Institute on dues of $5 a year; and it is evident that it is not practical to operate on this amount, and, therefore, the increase in dues is imperative.

The Institute is engaged in selling service to its members: this service can be made efficient and will increase in amount, just in proportion as it is supported by the members and as the number of members increases. The Institute has unquestionably passed through an important decade in its existence and from now on its growth will undoubtedly be rapid; it will become stronger and more important as time goes on. It has been a great pleasure to serve this Institute and do all that was possible for its development.

The influence of the Institute is expected to be greatly increased through the publication of the JOURNAL, which made its initial appearance with the December number in 1913.

The purpose of this JOURNAL is to increase the activities of the Institute and maintain the interest of its members in the interim between Conventions in three ways: first through the circulation in smaller and more convenient form for current use of the reports, papers and discussions presented at the previous Convention, and information concerning the work of the Institute and of its Committees; second, the publication of papers and discussions which have not been presented, although they may be the subjects for discussion at the Convention, and third, the preprinting of reports and papers to be presented at the Convention.

Beginning with the current March number, the JOURNAL will carry advertisements, the revenue from which is expected to cover, at least, the cost of its publication.

The Presidency was originally undertaken for the one year only, but conditions seemed to make it desirable, from the point of view of the needs of the Institute, that the speaker should continue as President, with the expectation each year that the conditions would so improve that another man could take up the reins of government. Ten years have elapsed under these conditions and the speaker trusts that the members of this Institute will feel that the service rendered has been an unselfish one, with no desire or thought of personal gain; but with the hope that the Institute could be made permanent, could be raised to a high position among the national societies of this country and placed in such a flourishing state that the future administration of its affairs would be not unduly handicapped by conditions which make efficient work difficult. When the speaker accepted the Presidency last year, he stated * * * "In accepting this election for the tenth time, I wish to give you warning, so you may have an opportunity for considering available candidates during the coming year, that I will not under any condition accept a re-election" * * * and that he believed at that time he foresaw the end of the difficulties which have confronted the Institute. It is his hope that this belief has been realized and he wishes to acknowledge his deep obligations to all the friends of this Institute and of himself, through whose generous co-operation it has been possible for him to realize this belief. The speaker, at the close of this convention will, with a feeling of relief, turn over to his successor the duties of President; this does not mean a severance of his connection with the Institute, since he will always be at its service and his best energies and endeavors will be directed to its development. He bespeaks for his successor the same generous support that you have accorded him; it would be unfair not to acknowledge the support which his successor, as a member of the official family, has always given to the speaker during all these years of association. Mr. Leonard C. Wason has been a devoted supporter of this Institute and it is but just, in recognition of this devotion, that you should honor him with the Presidency.