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Roadmap

Checking strength compliance
 versus evaluating existing structure

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- Basis of Chapter 9 provisions
- John Hanson's 2000 Survey of Practice
- Conclusions

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Core diameter

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• little difference between 6" and 4" (150 mm and 100 mm) core strengths

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- 2" (50 mm) cores on average weaker than 4" (100 mm) cores
 - Yip & Tam (1988): correction factor ranged from 0.63 to 1.53
 - develop appropriate correction factor from test data (if practical?)

Condition Factor soaked 1.09 Standard 1.00

0.96

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Uncertainty of in-place strength

- core strengths differ
- sample size often small

air dried

- in-place strengths differ
- empirical correction factors also uncertain

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	Within-	struct	ure varia	tion	
		$f_{c,eq}^{'} =$	$= C(\bar{f}_c)_C$	L	
			One Member	Many Members	
	One batc	:h	C = 0.91	0.89	
	Many bat	tches			
	Cast-in	-place	<i>C</i> = 0.85	0.83	
	Precas	t	0.88	0.87	
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Fact	or Ap	proa	eranc ch
	2530 ps	si value	
Confidence Level	in (psi)	out (psi)	Range (psi)
75%	3200	3780	580
90%	2970	3620	650
	2700	3510	720

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Str Alter	engths nate A	s using Approa	Andread Contract Back			
	2530 psi value					
Confidence Level	in (psi)	out (psi)	Range (psi)			
75%	3390	3560	170			
90%	3260	3460	200			
95%	3180	3400	220			
Higher strengths lower strengths f	for high or lower	CoV, CoV				
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Conclusions

4. Procedures yield equivalent-tospecified strength, consistent with customary resistance factors as the 10% fractile of the in-place strength.

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5. Alternate approach is less sensitive than tolerance factor approach if possible outliers present.

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Questions

• Now

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Later: f.m.bartlett@uwo.ca



Casimir J. Bognacki, PE, FACI, is the Chief of Materials Engineering at The Port Authority of New York and New Jersey. He has over 30 years of experience in construction materials and is currently responsible for managing the inspection and testing services for these materials, and investigating and incorporating the latest in materials technology into construction and maintenance work at Port Authority facilities Mr. Bognacki received his BS and MS in Civil Engineering from the Polytechnic

University in New York. He is a Fellow of the American Concrete Institute (FACI) and previously served as Chairman of ACI Committee 214, "Evaluation of Tests Results Used to Determine the Strength of Concrete". Mr. Bognacki is also a voting member of ACI Committees: 121, "Quality Assurance Systems for Concrete"; 211, "Proportioning Concrete Mixtures"; 212, "Chemical Admixtures"; 304, "Measuring, Mixing, Transporting, and Placing Concrete"; 562, "Evaluation, Repair, and Rehabilitation of Concrete Buildings". He is an officer of the NJ Chapter-ACI and the Concrete Industry Board of NYC.































	MOCK-U	P – MIX DE	ESIGNS	Altineing course browindp
		# 1	# 2	# 3
	Cementitious Factor (lbs.)	1029	941	820
	Cement Factor (lbs.)	695	682	300
	Slag (lbs.)			367
	Fly Ash, Class C (lbs.)	301	234	129
	Silica Fume (lbs.)	33	25	24
	Sand (lbs.)	1375	1457	1338
	Stone- 57/67 (lbs.)	1080	1040	1143
	Stone – 8 (lbs.)	450	500	490
	W/C	0.25	0.29	0.27
	Air Content (%)	1.9	2.6	1.7
	Slump / Flow (in.)	10.75	9.75	(20)
	Unit Weight C-39 (pcf)	154.5	151.7	155.6
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	ve	rtical	Horizontal				
and an open set	Edge	Center	Edge	Interior			
Number of Cores	8	9	7	7			
Avg. Compressive Strength (psi)	15,780	15,570	16,380	15,470			
Coefficient of Variation (%)	57	3 80		5 /			
verage Core Streng verage Cylinder Str laximum Curing Te ercent Reduction in	th – ength - mperature - Compressive S	5.60 15. 17. 16. Strength - 9%	.780 psi @ 205 dz .290 psi @ 56 day 2°F @ 42 hours 6	5. 4 ys s			

	Ve	rtical	Horizontal			
	<u>Edge</u>	<u>Center</u>	Edge	<u>Interior</u>		
Number of Cores	10*	10	7	6		
Avg. Compressive Strength (psi)	12,320	12,880	12,560	12,870		
Coefficient of Variation (%)	6.70	6.00	5.60	2.80		
Average Core Strength - 12,640 psi @ 221 days *Tested at 173 days Average Cylinder Strength - 18,140 psi @ 56 days *Tested at 173 days Maximum Curing Temperature - 18,140 psi @ 56 days * Barnent Reduction is formute in Strength 1837 @ 30 hours *						

WTC – TCA 1001.04 TOWER ONE, FC' = 14,000 PSI	Annelian Sociale Instate Advance on the social
CEMENT (LBS.)	300
FLY ASH (C) (LBS.)	65
SLAG (LBS.)	483
SILICA FUME (LBS.)	25
SAND (LBS.)	1160
STONE (#67 & #8) (LBS.)	1646
WATER (LBS.)	220
WATER REDUCER (OZ.)	30
HIGH RANGE WATER REDUCER (OZ.)	65
W/C	0.25
	-20/
AIR 70	<270
	Æ
WED SESSIONS	THE PORTAUTHORITY OF NY& NJ

	Anetaa Cacceste Instate
WTC - TOWER ONE RESU	LTS
COMPRESSIVE STRENGTH - 56 DAYS	16,160 PSI
STANDARD DEVIATION	1,010 PSI
COEFFICIENT OF VARIATION	6.25%
MODULUS OF ELASTICITY 90 DAYS	7.5% X 10 ⁶ psi
AIR CONTENT	1.7%
W/C RATIO (MICROWAVE)	.29
UNIT WEIGHT	153.9 PCF
SPREAD	25 IN.
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	Stan	dard C	ylin	ders	Cylin	ders C	ast In-	-Slab		Cor	es	
Block#	PSI	Avg PSI	Within test Std. Dev.	Within -test CV %	PSI	Avg. PSI	Within- test Std. Dev.	Within- test CV %	PSI	Avg PSI	Within -test Std. Dev.	Within- test CV %
Normal	15011 13645 14685	14450 **see note	577	3.75	13755 13645 12365	13260	950	6.80	15979 15779 16300	16020	393	2.56
Dry	16202 15398 15033	15540	577	3.75	11617 14753 13790	13390	950	6.80	14472 14464 14868	14600	393	2.56
160	15738 16306 15295	15780	577	3.75	14722 14458 14650	14610	950	6.80	15420 15975 16041	15810	393	2.56
190	15557 15922	15740	475	3.09	13806 15451 14652	14640	950	6.80	15573 14460 14898	14980	393	2.56
Avg		15790*** 15380				13970				15350		
Std. Dev		629				754				673		
ACI WEB	SESSI	4.09%	•• C) •••A\	LINDEF /ERAGE	R RESULTS	5.40% S ARE MIS	LEADING IE THE 14,	450 PSI	1	4.39%	UTHORIT	OFNY&NJ











Bryan R. Castles is a Principal and Senior Materials Engineer for Western Technologies, Inc., Phoenix, AZ. He has extensive experience with construction quality control methods and procedures and has provided quality-control management and administrative services for numerous DOT, Corps of

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Engineers, and FAA projects. He is an active member of ACI and Past President of the ACI Arizona Chapter. He is a member of ACI Committees 211, Proportioning Concrete Mixtures; 214, Evaluation of Results of Tests Used to Determine the Strength of Concrete; 221, Aggregates; and E702, Designing Concrete Structures. In 1983, he received his BS in civil engineering at the University of Illinois, Urbana-Champaign. He is a licensed professional engineer in Arizona, Colorado, and Nevada.)



The Hotel Monroe

Downtown Phoenix
Built in 1931
13 stories, reinforced concrete
Slated for rehabilitation (2008)
Floors: slabs & joists

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Goal: f_c for fire resistance of slabs

- Data to be submitted to Fire Protection Engineer
- Also needed: thickness and unit weight
- Sampling plan: ASTM E122 for number of cores per floor



Coring: preliminary analysis

• Total obtained: 51

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- · 4 cores rejected: too short
- · 12 with wire reinforcement
- T-test shows "reinforced" cores stronger than plain cores removed
- Visual observation: good quality concrete





Core test results summary

- Diameter: 2 3/4 inches
- Length: 2 3/4 to 6 3/4 inches
- Average UW: 143 pcf
- Average strength, no correction: 5658 psi
- Standard Deviation s = 1058







	"Diamete	er≠4	inches" correction	for Courte Hother
		2 in. (50 mm)	1.06	
	F _{dia} : core diameter	4 in. (100 mm)	1.00	
		6 in. (150 mm)	0.98	
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						-	
	Floor	Data	All Data	Culled	Final		acity
		Average of Core Strength	5874	5890	6025		American Concrete Institute
		StdDev of Core Strength	528	746	1057		
		Average of Core Strength			6586		
		StdDev of Core Strength	548				
		Average of Core Strength	6046	6231	6269		
		StdDev of Core Strength			860		
		Average of Core Strength	5207	4581	4693		
		StdDev of Core Strength	1426		950		
		Average of Core Strength	4978	4978	5048		
		StdDev of Core Strength					
		Average of Core Strength	8334				
		StdDev of Core Strength	1958				
		Average of Core Strength	5745	5745	5856		
		StdDev of Core Strength			1355		
		Average of Core Strength	6378	6100	6297		
		StdDev of Core Strength					
		Average of Core Strength	6052	5756	6086		
		StdDev of Core Strength					
		Average of Core Strength	4753	4753	4985		
		StdDev of Core Strength	905	905			
		Average of Core Strength	6467	6467	6639		
		StdDev of Core Strength			1058		
		Average of Core Strength	5320	5616	5678		
		StdDev of Core Strength		606			
ACI		otal Average of Core Strength	5997	5658	5791		
WEB SESSIONS		Total StdDev of Core Strength	1351	1058	1068		













	A	opplication to	o proje	ect dat	a					
	Confidence level									
	f' _c equivalent (psi)	Method	75%	90%	95%					
		Tolerance factor approach	4160	3996	3882					
		Alternate Approach	4397	4024	3803					
	Table : judgm	submitted to Fire Protectio ent	n Engineer fo	r use per his						
A. A	CI VEB SESSIONS	ACI Spring Conv Fic	ention 2011 Tampa rida							



