American Concrete Institute®
Advancing concrete knowledge

Concrete Proportioning in Hawaii

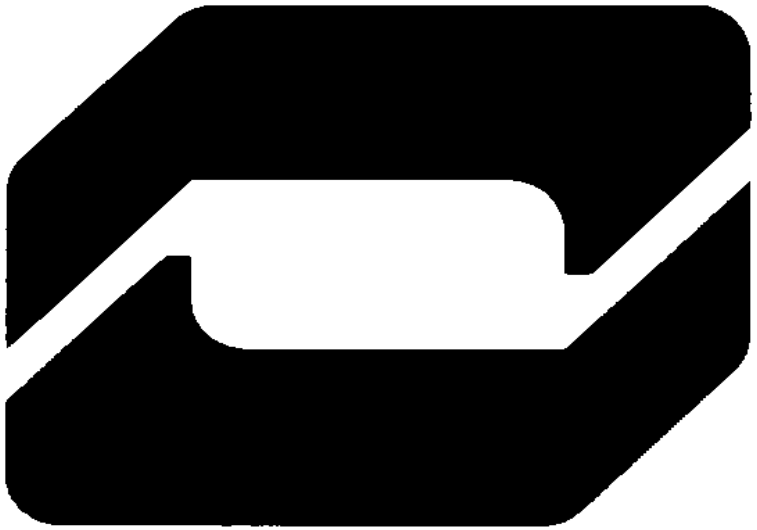
ACI 2013 Spring Convention

Hilton Minneapolis & Convention Center

April 15, 2013

Twin Cities Spring 2013 Responsibility in Concrete Construction

HAWAIIAN CEMENT



HAWAIIAN CEMENT

Timothy Folks
Manager, Technical Services

Hawaiian Cement
Aiea, Hawaii
808-483-3392

Concrete Proportioning Challenges

Challenges

- Location
- Cost
- Perceptions
- Materials
- Regulations

Blessings

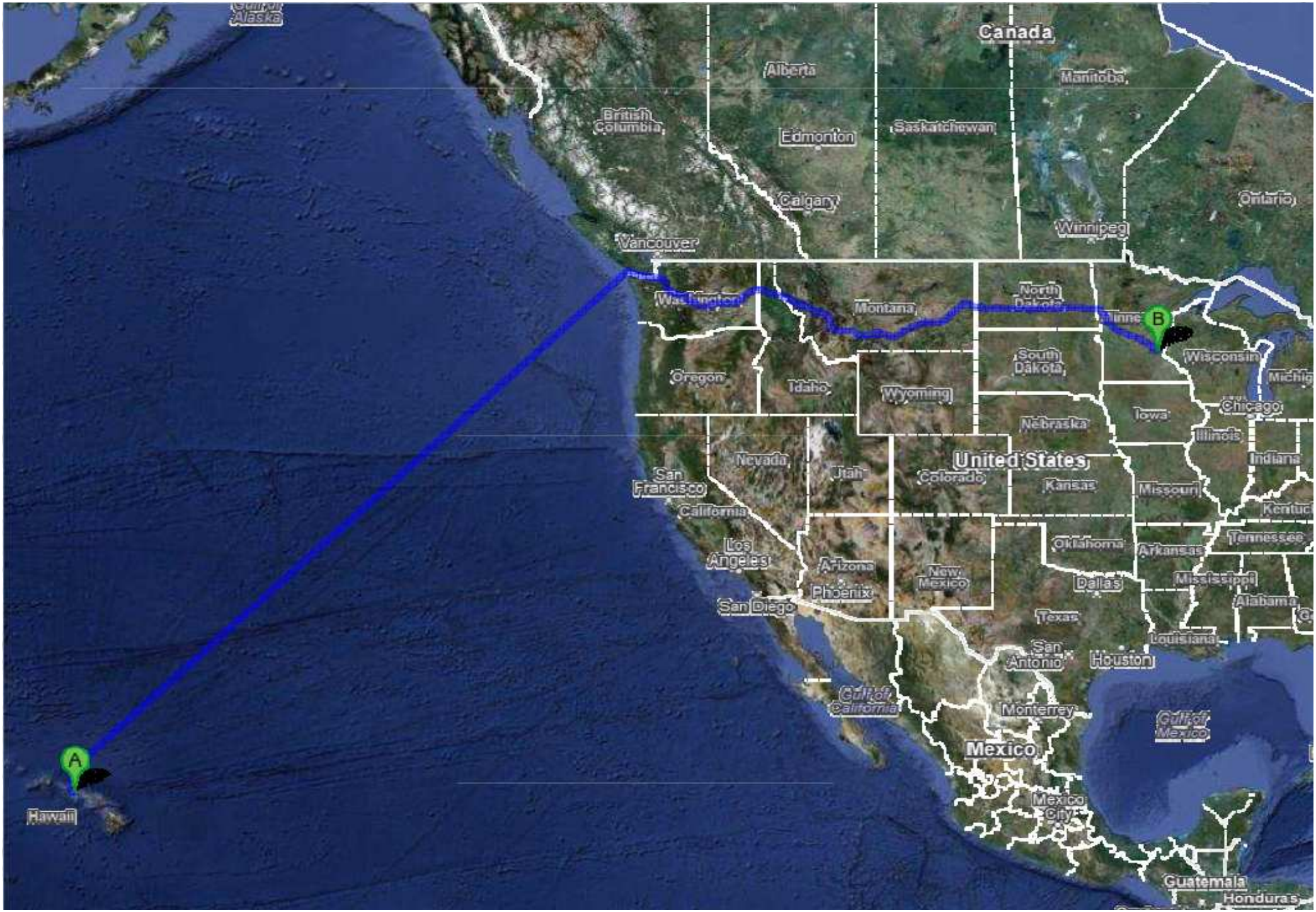
- Location
- Quarry on each island
- Real Story
- Local non-spec fly ash
- Aloha Spirit

Location

Your realtors will always tell you

…

“Location, location, location!”


Canada
Alberta
Manitoba
British Columbia
Edmonton
Saskatchewan
Calgary
Ontario
Winnipeg
Vancouver
Washington
Montana
North Dakota
Minnesota
B
Wisconsin
Michigan
South Dakota
Oregon
Idaho
Wyoming
Chicago
Nebraska
Iowa
Illinois
Indiana
Nevada
Utah
United States
Colorado
Kansas
Missouri
San Francisco
California
Kentucky
Tennessee
Oklahoma
Arkansas
Los Angeles
Arizona
New Mexico
Dallas
Mississippi
Phoenix
Alabama
San Diego
Texas
Louisiana
San Antonio
Houston
Gulf of California
Monterrey
Gulf of Mexico
Mexico
A
Mexico City
Hawaii
Guatemala
Honduras

DIRECTIONS

1. Head **west** on **Halawa Valley St**

2. Take the ramp onto **I-H-1 W**

3. Keep right to continue on **I-H-2 N**

4. 

12. Sail across **the Pacific Ocean** Entering Washington 2,756 mi

13. 

30. Hilton Minneapolis, 1001 Marquette Ave S, Minneapolis, MN 55403

Total Distance: 4,452 mi, 136 hours

High Cost of Everything!

- Most consumables arrive by boat (98%).
  - Food
  - Clothes
  - Fuel
  - Etc.
- High Price of Homes and Property
  - Most building materials arrive by boat too


HOKULEA


Mateon

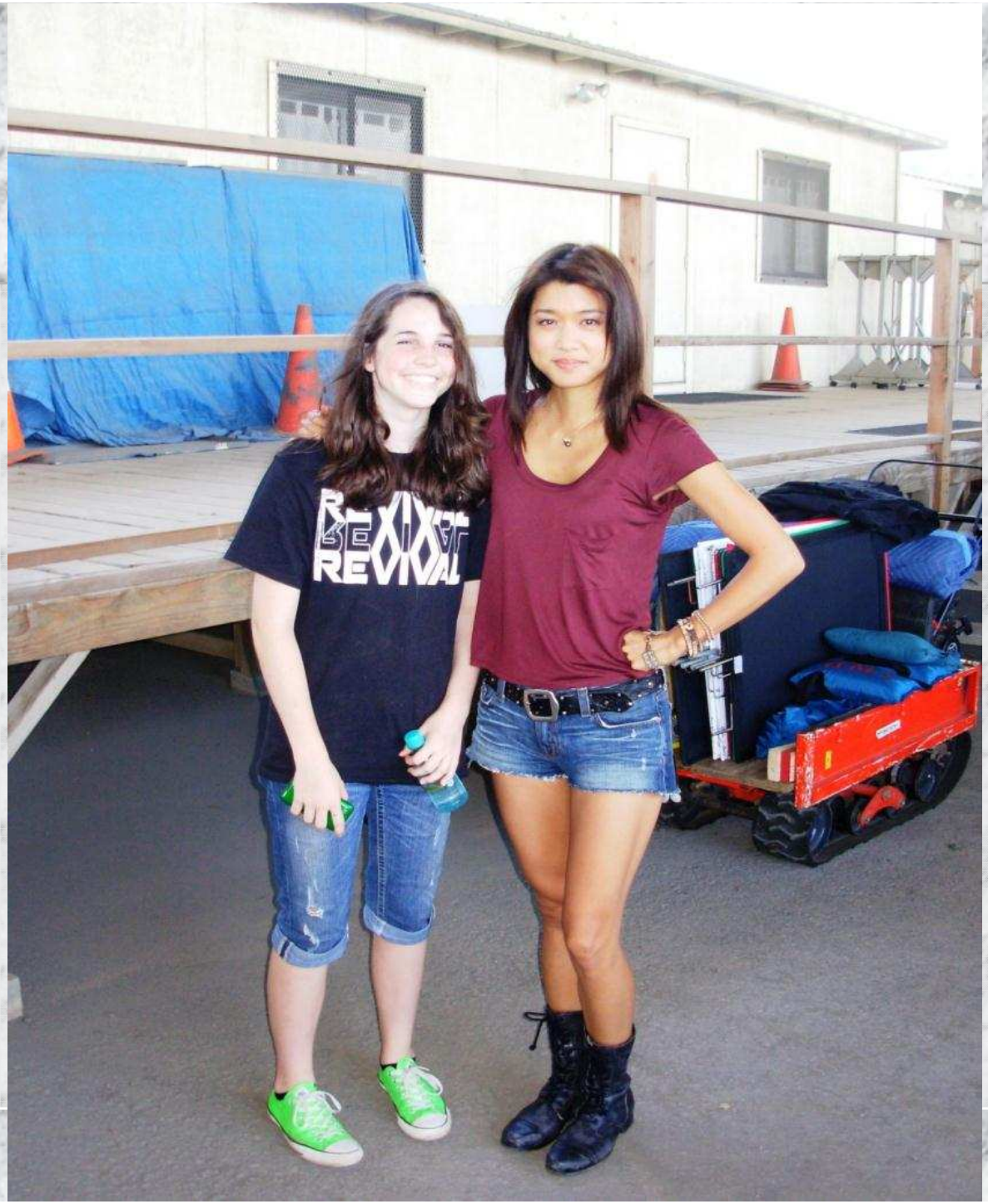
Perceptions

"Hawaii is a third world country that uses American Money!"

The Real Story

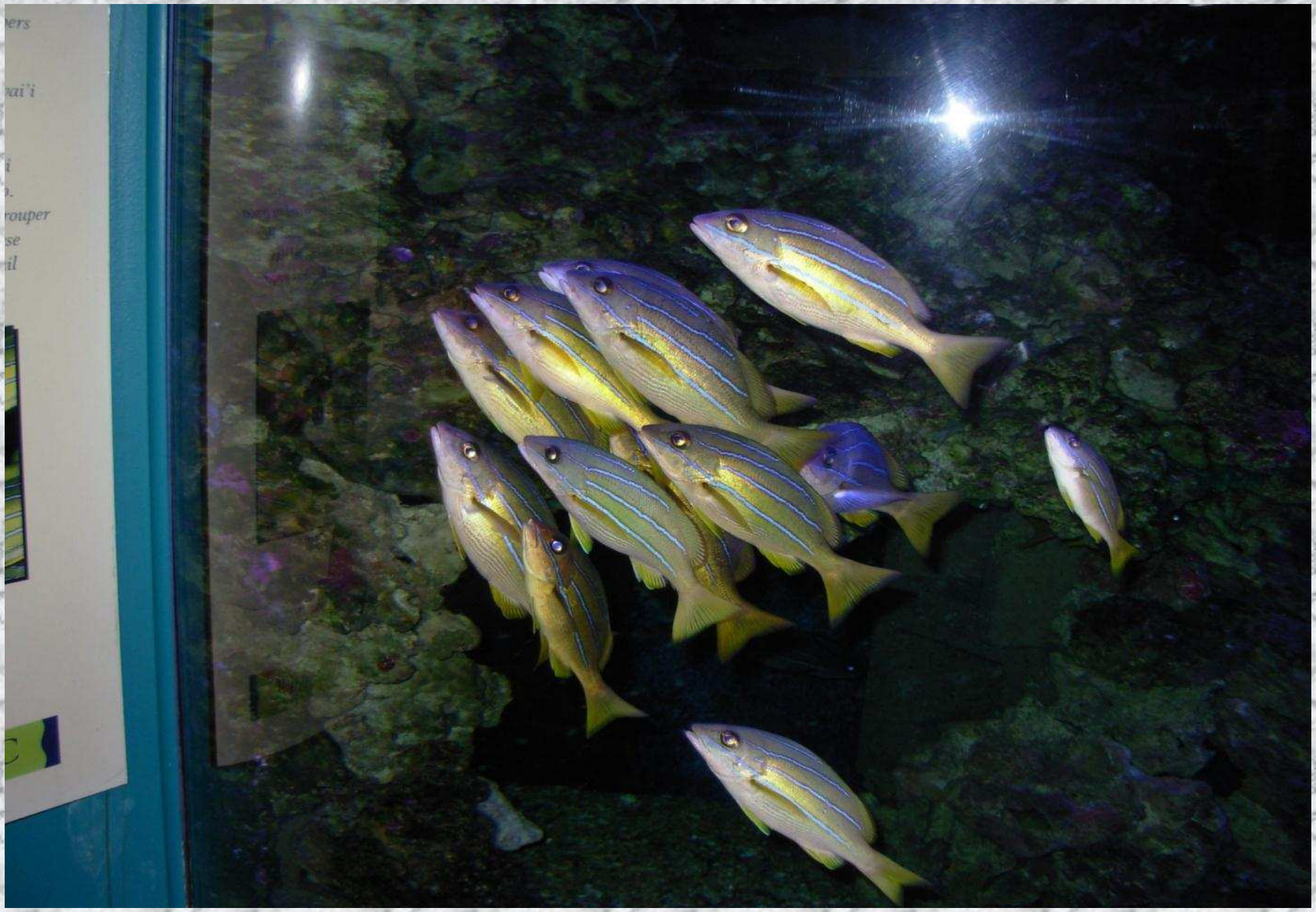
Never say “back in the states…”

Hawaii is the 50th State!


REVIVAL


SEA ELEGANCE


HITACHI
EX1200



Materials

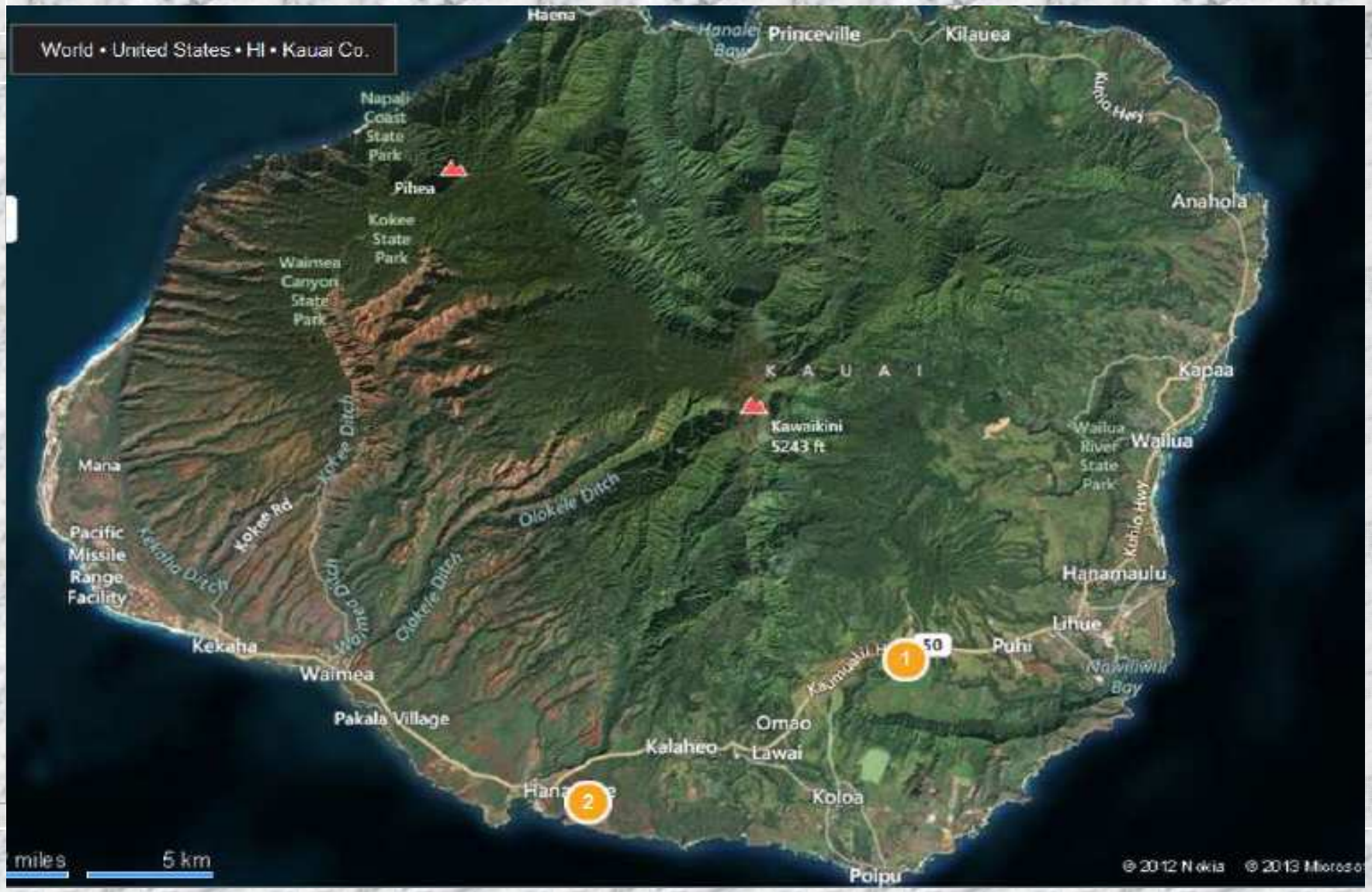
Quarries In Hawaii

- Kauai
  - Jas Glover (Lihue)
  - O Thronas (Eleele)
- Oahu
  - Hawaiian Cement (Halawa)
  - Ameron Hawaii (Kapaa)
  - Grace Pacific (Makakilo)
- Molokai
  - Grace Pacific

Quarries In Hawaii

- Lanai
  - Lanai Co.
- Maui
  - Hawaiian Cement (Waikapu & Puunene)
  - Ameron Hawaii (Puunene)
- Hawaii
  - West Hawaii Concrete (Waimea & Kona)
  - YS Rock (Hilo)
  - Jas Glover (Hilo)

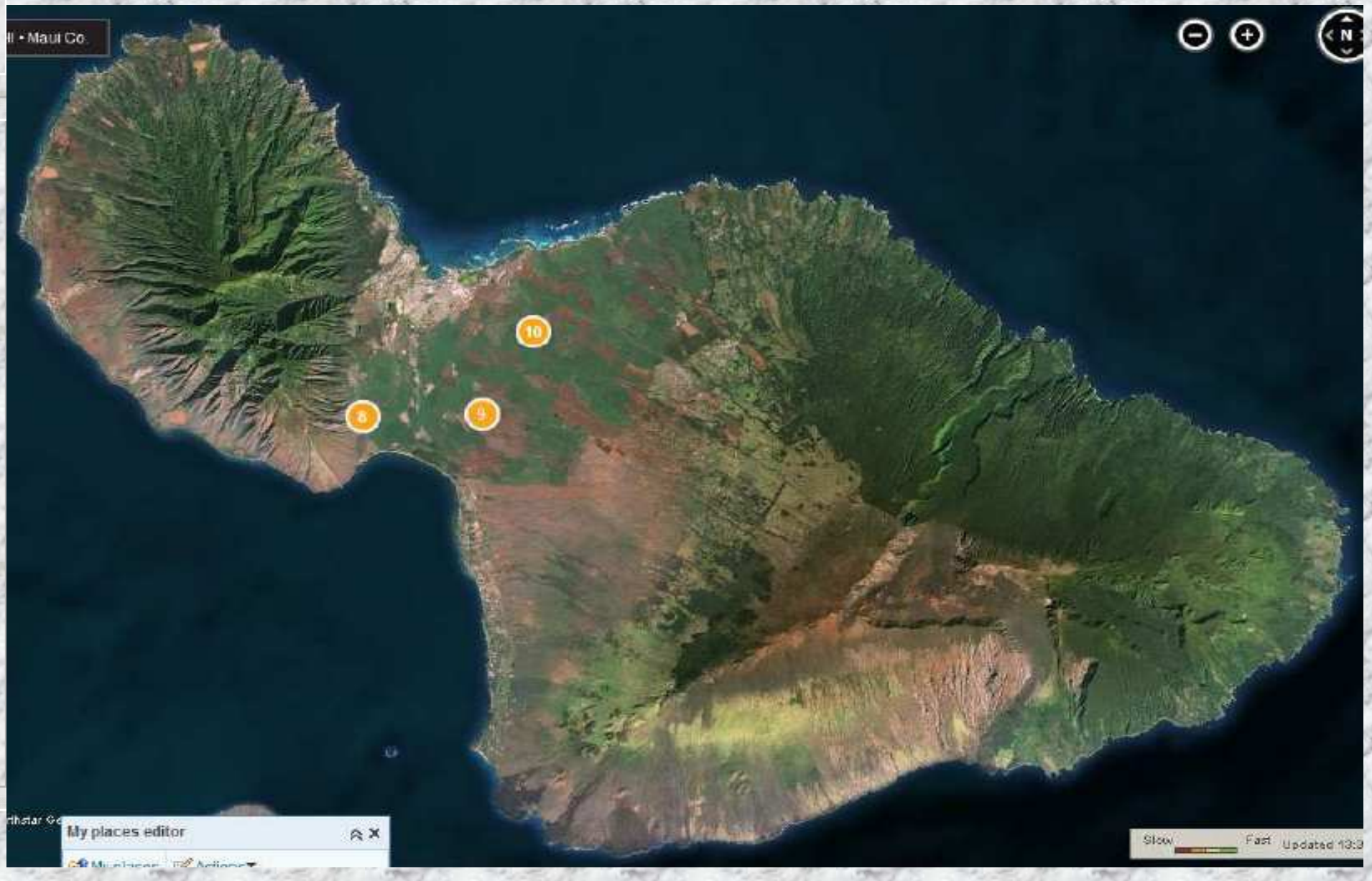
Island of Kauai



Island of Oahu

Islands of Molokai & Lanai

Island of Maui



Island of Hawaii


CSL
C S L


CSL

Mix Proportioning Example

4000-¾” REGULAR

Proportioning Concrete Mixes

- 4” Thick Slab on Grade
- No Freeze Thaw, no deicer
- Specified Strength 4,000 psi
- Non-reinforcement
- No Mix Statistical Data
- 3/4” Crushed Stone, Sp. Gr. = 2.65, Dry-Rodded Unit Weight = 96 pcf
- Manufactured Sand, Sp. Gr.=2.65, Fineness Modulus = 3.20

Concrete Proportioning Tables

ACI 211.1R

Table 6.3.4(b) - Maximum permissible water-cement or water-cementitious materials ratios for concrete In severe exposures*

Type of structure	Structure wet continuously or frequently and exposed to freezing and thawing+	Structure exposed to sea water or sulfates
Thin sections (railings, curbs, sills, ledges, ornamental work) and sections with less than 1 in. cover over steel	0.45	0.40+
All other structures	0.5	0.45+

*Based on report of ACI Committee 201. Cementitious materials other than cement should conform to ASTM C 618 and C 989. "Concrete should also be air-entrained

+If sulfate resisting cement (Type II or Type V of ASTM C 150) is used, permissible water-cement or water-cementitious materials ratio may be increased by 0.05.

Required Average Compressive Strength When Data are not Available to Establish a Standard Deviation (ACI 301-10 Table 4.2.3.3.b and ACI 318-08 Table 5.3.2.2)

Specified compressive strength, f'_c, psi	Required average compressive strength, f'_{cr}, psi
Less than 3000	$f'_c + 1000$
3000 to 5000	$f'_c + 1200$
Over 5000	$1.10f'_c + 700$

PCA Table 12-10

Relationship Between Water-Cementitious Ratio and Compressive Strength of Concrete (ACI 211.1-97 Table 6.3.4(a))

Compressive strength at 28 days, psi	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
7000	0.33	-
6000	0.41	0.32
5000	0.48	0.40
4000	0.57	0.48
3000	0.68	0.59
2000	0.82	0.74

5,200 psi requires approximately 0.47 w/c

PCA Table 12-3

Approximate Mixing Water and Target Air Content Requirements for Different Slumps and Maximum Sizes of Aggregates (ACI 211.1-97 Table 6.3.3)

Slump, in.	Water, pounds per cubic yard of concrete for indicated maximum sizes of aggregate							
	3/8 in.	1/2 in.	3/4 in.	1 in.	1 1/2 in.	2 in.	3 in.	6 in.
	Non-Air-Entrained Concrete							
1 to 2	350	335	315	300	275	260	220	190
3 to 4	385	365	340	325	300	285	245	210
6 to 7	410	385	360	340	315	300	270	-
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
	Air-Entrained Concrete							
1 to 2	305	295	280	270	250	240	205	180
3 to 4	340	325	305	295	275	265	225	200
6 to 7	365	345	325	310	290	280	260	-
Recommended Average Total Air Content, percent, for Level of Exposure								
Mild Exposure	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
Moderate Exposure	6.0	5.5	5.0	4.5	4.5	3.5	3.5	3.0
Severe Exposure	7.5	7.0	6.0	6.0	5.5	5.0	4.5	4.0

PCA Table 12-5

Bulk Volume of Coarse Aggregate Per Unit Volume of Concrete (ACI 211.1-97 Table 6.3.6)

Nominal maximum size of aggregate, in. (mm)	Bulk volume of dry-rodded coarse aggregate per unit volume of concrete for different fineness moduli of fine aggregate				
	2.40	2.60	2.80	3.00	3.20
3/8 (9.5)	0.50	0.48	0.46	0.44	
1/2 (12.5)	0.59	0.57	0.55	0.53	
3/4 (19)	0.66	0.64	0.62	0.60	0.58
1 (25)	0.71	0.69	0.67	0.65	
1 1/2 (37.5)	0.75	0.73	0.71	0.69	
2 (50)	0.78	0.76	0.74	0.72	
3 (75)	0.82	0.80	0.78	0.76	
6 (150)	0.87	0.85	0.83	0.81	

PCA Table 12-4

Mix Proportioning Example

4000-¾” REGULAR

Proportioning Concrete Mixes

- 4” Thick Slab on Grade
- No Freeze Thaw, no deicer
- Specified Strength 4,000 psi
- Non-reinforcement
- No Mix Statistical Data
- 3/4” Crushed Stone, Sp. Gr. = 2.65, Dry-Rodded Unit Weight = 96 pcf
- Manufactured Sand, Sp. Gr.=2.65, Fineness Modulus = 3.20

Proportioning Concrete Mixes

- $f'_{cr} = f'_c + 1{,}200 = 4{,}000 + 1{,}200 = 5{,}200$ psi (ACI 318-08 Table 5.3.2.2)
- W/C (Table 6.3.4(b)) = NA and W/C (Table 6.3.4(a)) = 0.47
- 3/4" aggregate $\leq$ 1/3 thick, ~~3/4 distance between bars~~
- Air (Table 6.3.3) = entrapped only (2%)
- Slump (Table 6.3.1) = 1 to 3"
- Water (Table 6.3.3) = 340#

Proportioning Concrete Mixes

- Cement (340# H_2O / 0.47 W/C) = 723
- Coarse Aggregate (Table 6.3.6) 27 X 96 X 0.58 = 1503 #
- Air 2% Entrapped only
- Sand Make up Remaining Volume

Proportioning Concrete Mixes

- Sand Estimate
- Water = 340 / (1 X 62.4) = 5.449 cu. ft.
- Cement = 723 # / (3.15 X 62.4) = 3.678 cu. ft.
- Air = (2.0 / 100) X 27.00 = 0.540 cu. ft.
- Coarse Aggregate = 1503# / (2.65 X 62.4) = 9.089 cu. ft.
- Sand = 27 - 5.449 - 3.678 - 0.540 – 9.089 = 8.244
- 8.244 X 2.65 X 62.4 = 1363 # Sand

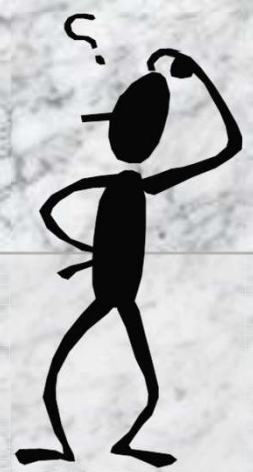
Mix Design

Criteria: 3/4” CA, Dry Rodded Unit Wt. = 96 pcf, 2.65 Sp.Gr.

FM = 3.20, 2.65 Sp.Gr., 2% air, Water 340#

Material	Sp.Gr.	Weight/cy	Abs.Vol., cu. ft.
Cement	3.15	723	3.678
Fly Ash	2.50	0	0
Coarse Agg	2.65	1503	9.089
Fine Agg	2.65	1363	8.244
Water	1.00	340	5.449
AEA	NA	2.0%	0.540
WR			
		3928 #	27.000 cu.ft.

What Next?



- Check you calculations and then . . .
- Check you mix with a trial batch, then adjust

AND / OR

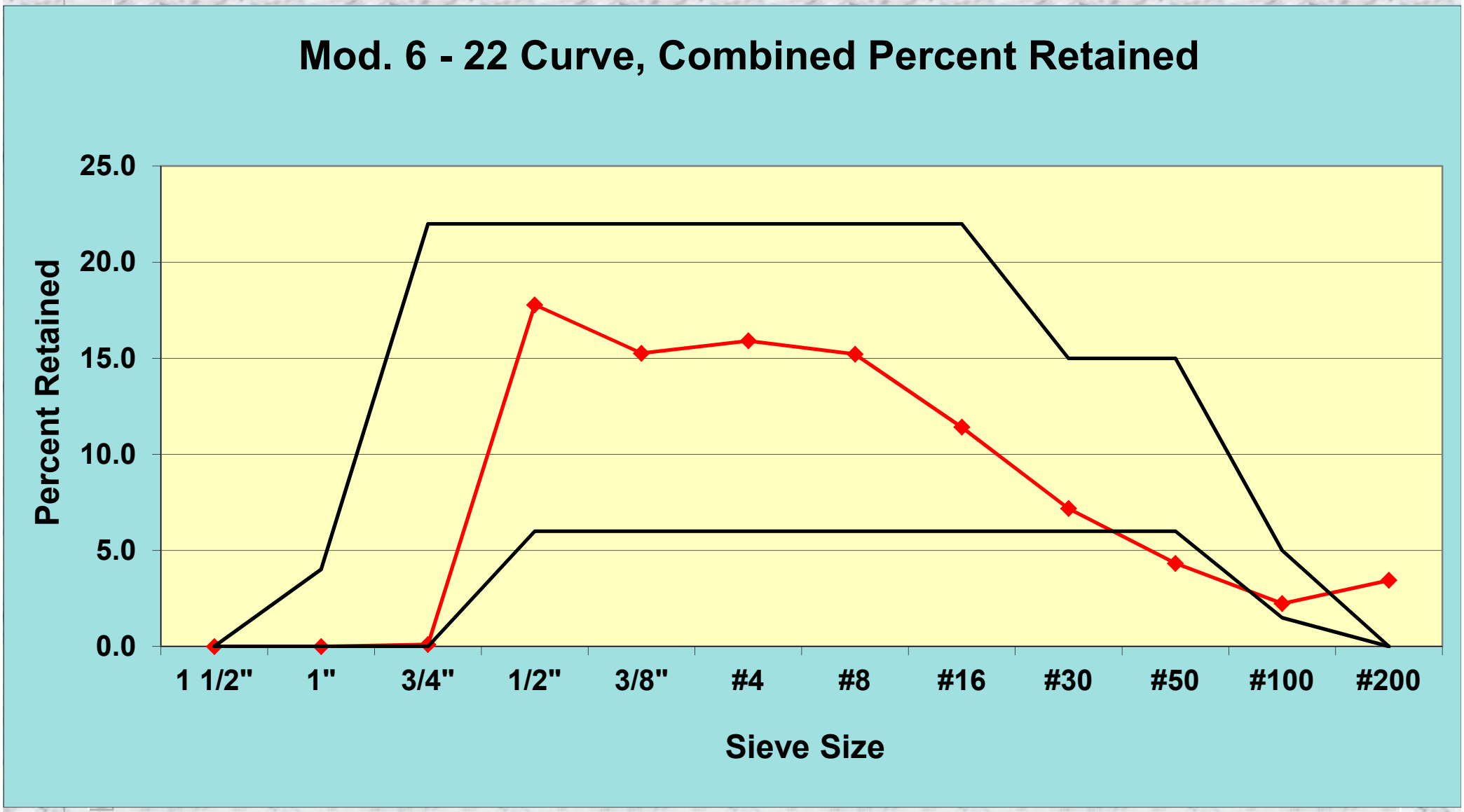
- Optimize the mix

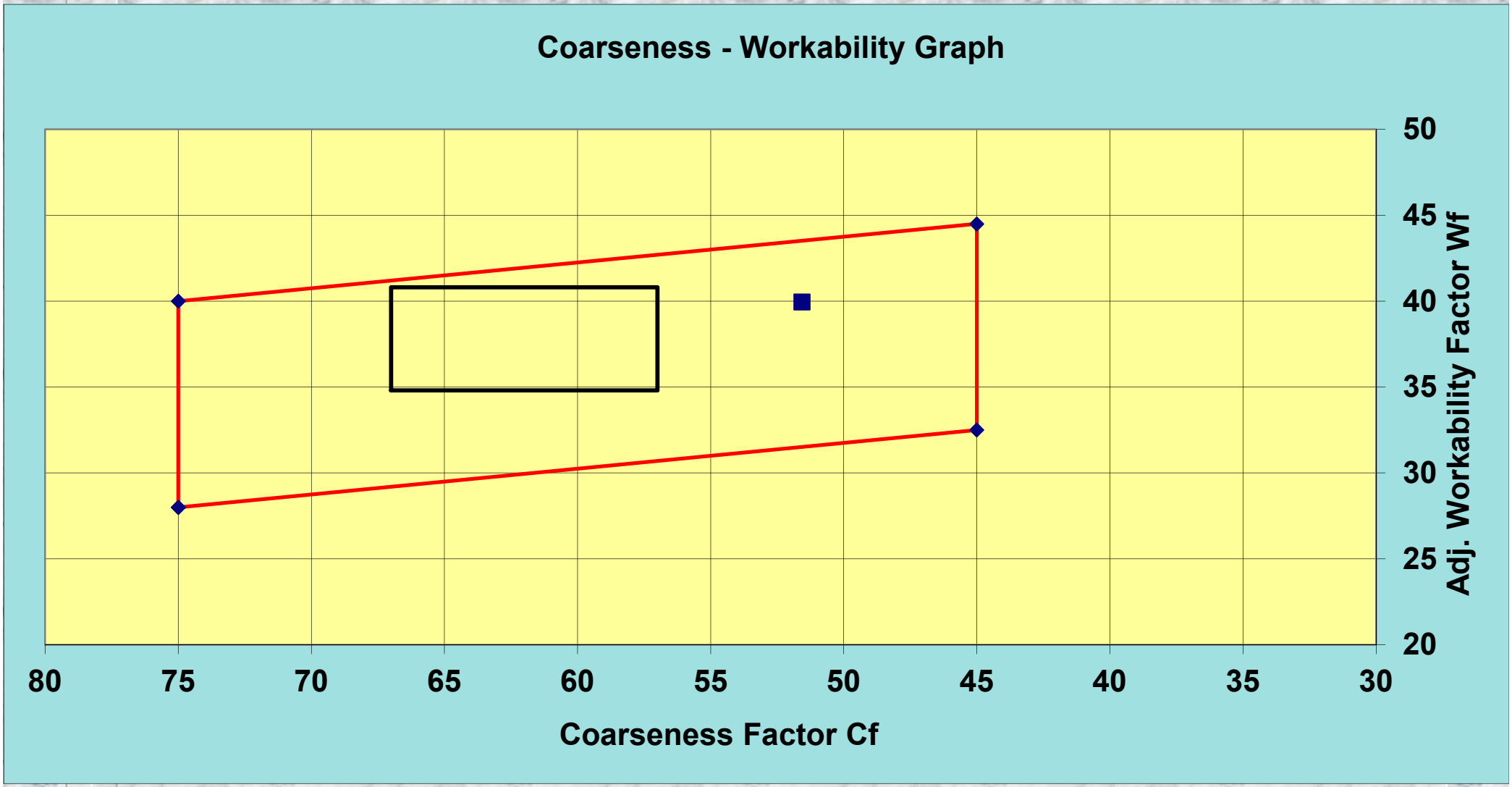
Sieve	3CH Coarse Aggregate 1 Cumulative Percent Passing	3CH Coarse Aggregate 1 Indiv. Percent Retained	3FW Coarse agg. 2 Cumulative Percent Passing	3FW Coarse agg. 2 Indiv. Percent Retained	3/8H Intermediate agg. Cumulative Percent Passing	3/8H Intermediate agg. Indiv. Percent Retained	#4H Fine Aggregate 1 Cumulative Percent Passing	#4H Fine Aggregate 1 Indiv. Percent Retained	N4S Fine Aggregate 2 Cumulative Percent Passing	N4S Fine Aggregate 2 Indiv. Percent Retained	BC Sand-O Fine Aggregate 3 Cumulative Percent Passing	BC Sand-O Fine Aggregate 3 Indiv. Percent Retained
1 1/2"	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
1"	88.6	11.42	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
3/4"	38.9	49.72	99.8	0.20	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
1/2"	6.9	31.97	65.9	33.90	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
3/8"	4.3	2.61	36.8	29.10	97.1	2.86	100.0	0.00	100.0	0.00	100.0	0.00
#4	1.9	2.36	9.1	27.70	8.1	89.03	97.1	2.90	95.0	5.00	97.2	2.80
#8	1.5	0.39	5.3	3.80	2.7	5.41	69.3	27.80	71.0	24.00	82.9	14.30
#16	1.2	0.31	5.3	0.00	2.0	0.67	45.3	24.00	51.2	19.80	68.6	14.30
#30	0.9	0.28	5.3	0.00	1.6	0.39	30.2	15.10	34.9	16.30	51.3	17.30
#50	0.8	0.17	5.3	0.00	1.3	0.39	21.1	9.10	16.2	18.70	26.1	25.20
#100	0.5	0.26	5.3	0.00	0.9	0.40	16.4	4.70	4.5	11.70	8.0	18.10
#200	0.2	0.30	1.0	4.30	0.5	0.40	13.9	2.50	1.7	2.80	3.1	4.90
FM	7.61		6.28		5.86		3.21		3.27		2.66	

SIX AGGREGATE BLEND

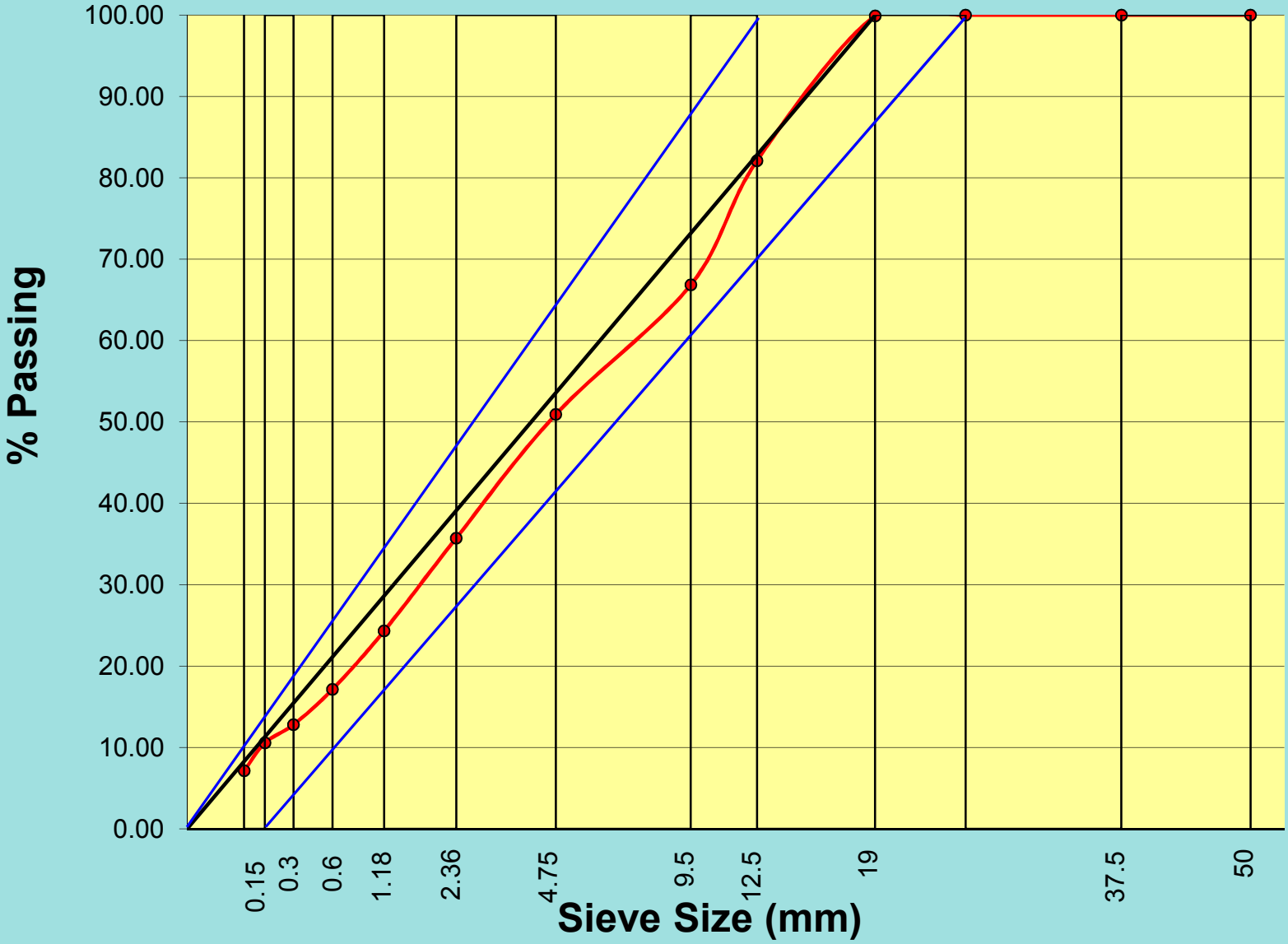
		TOTAL AGG BLEND	
	3CH	0.0 %	0 Lbs.
	3FW	52.5 %	1503 Lbs.
FINE AGG BLEND	3/8H	0.0 %	0 Lbs.
100.00%	#4H	47.5 %	1362 Lbs.
0.00%	N4S	0.0 %	0 Lbs.
0.00%	BC Sand-O	0.0 %	0 Lbs.
3.21 FM			
	Total=	100.0 %	2865 Lbs.
	Coarseness Factor (CF)	51.6	
	Workability Factor (W) =	35.7	
	Corrected =	40.0	4.82 Total FM

Sieve	Blend % Passing	Indiv. Percent Retained	Cumulative Percent Retained
1 1/2"	100.0	0.0	0.0
1"	100.0	0.0	0.0
3/4"	99.9	0.1	0.1
1/2"	82.1	17.8	17.9
3/8"	66.8	15.3	33.2
#4	50.9	15.9	49.1
#8	35.7	15.2	64.3
#16	24.3	11.4	75.7
#30	17.1	7.2	82.9
#50	12.8	4.3	87.2
#100	10.6	2.2	89.4
#200	7.1	3.4	92.9


Mod. 6 - 22 Curve, Combined Percent Retained
Percent Retained
25.0
20.0
15.0
10.0
5.0
0.0
1 1/2"
1"
3/4"
1/2"
3/8"
#4
#8
#16
#30
#50
#100
#200
Sieve Size


Coarseness - Workability Graph
50
45
40
35
30
25
20
Adj. Workability Factor Wf
80
75
70
65
60
55
50
45
40
35
30
Coarseness Factor Cf

0.45 POWER CHART

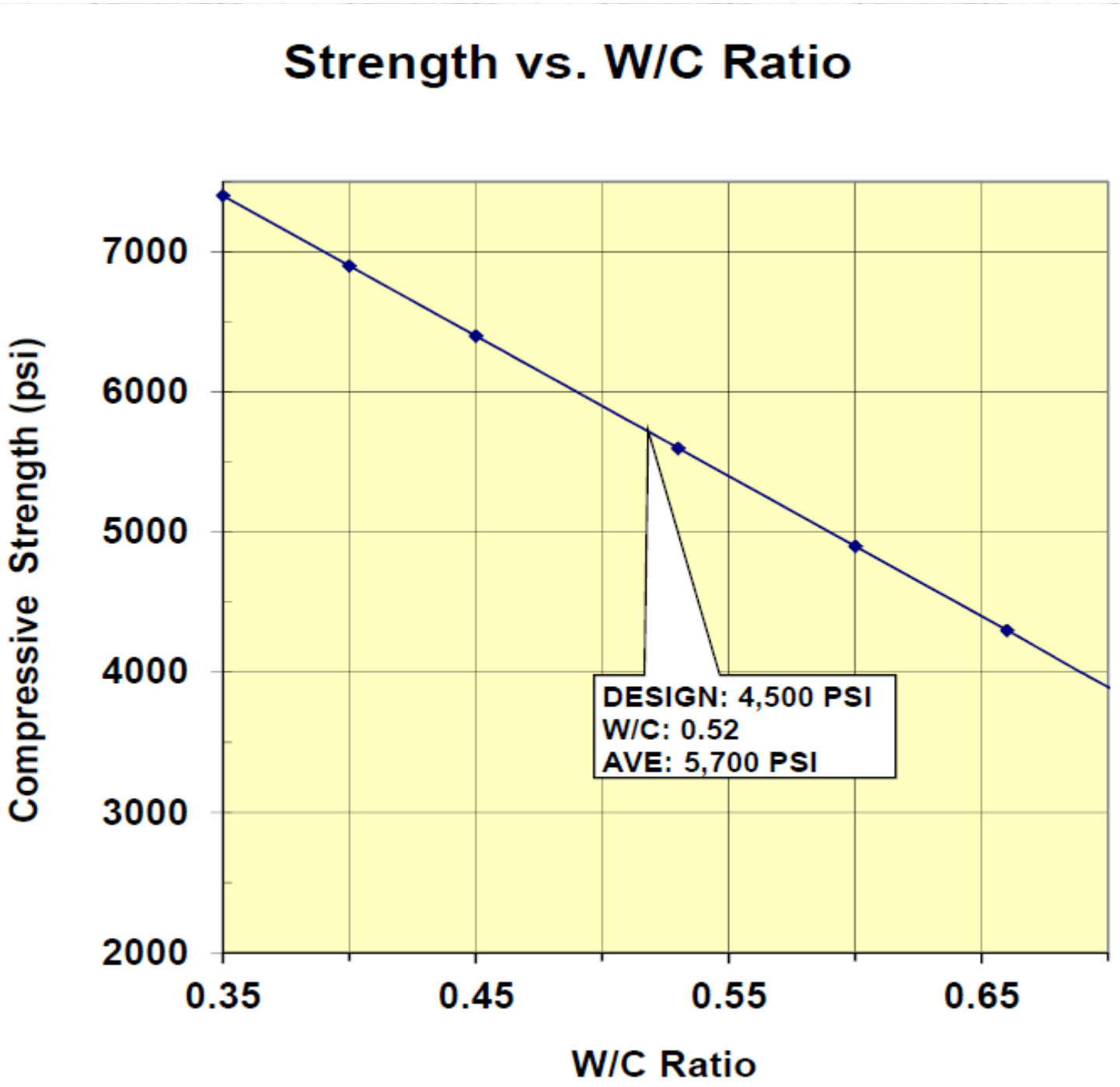


Optimizing Example

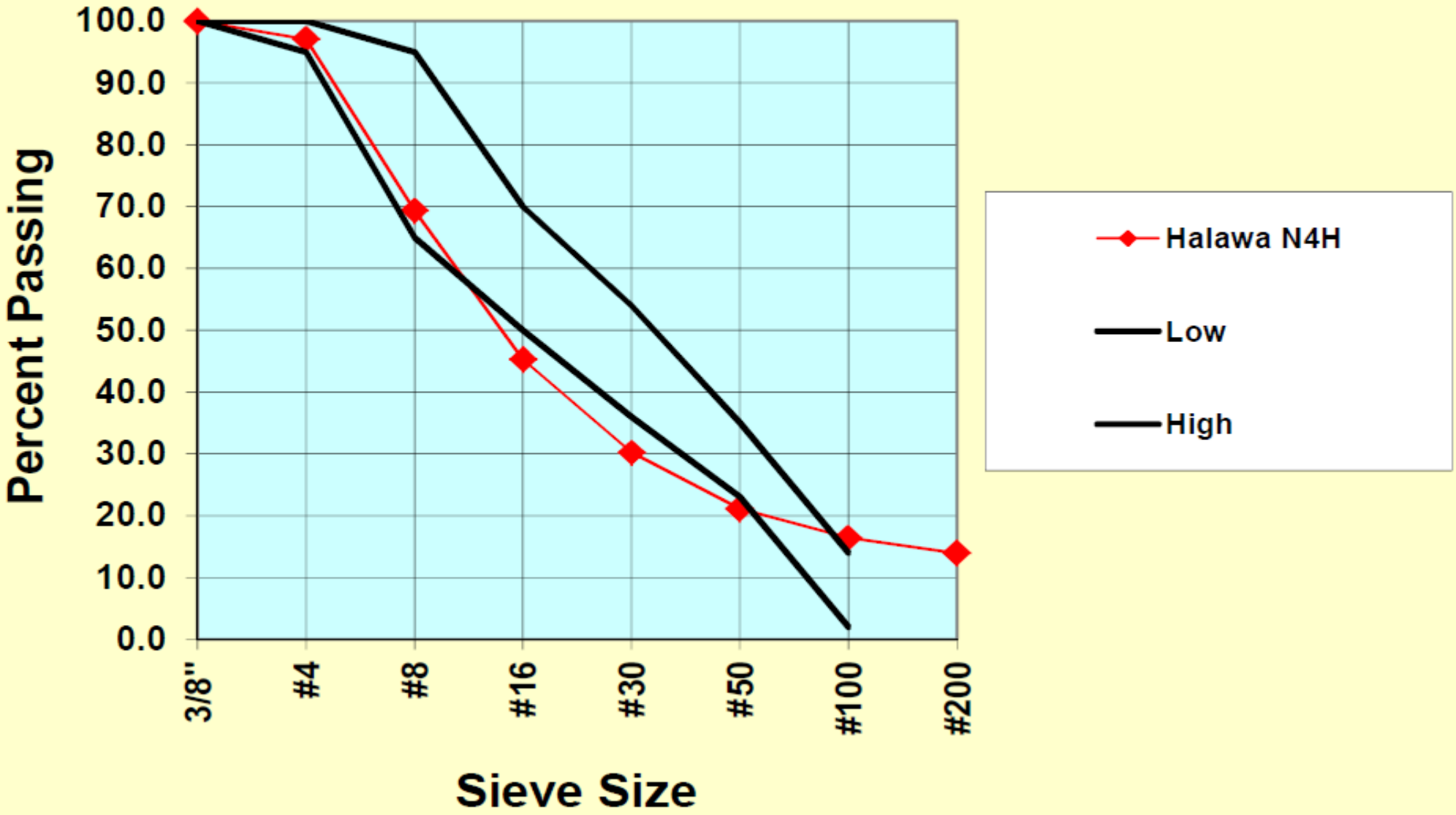
4000-¾” REGULAR (Continued)

Optimizing Concrete Mixes

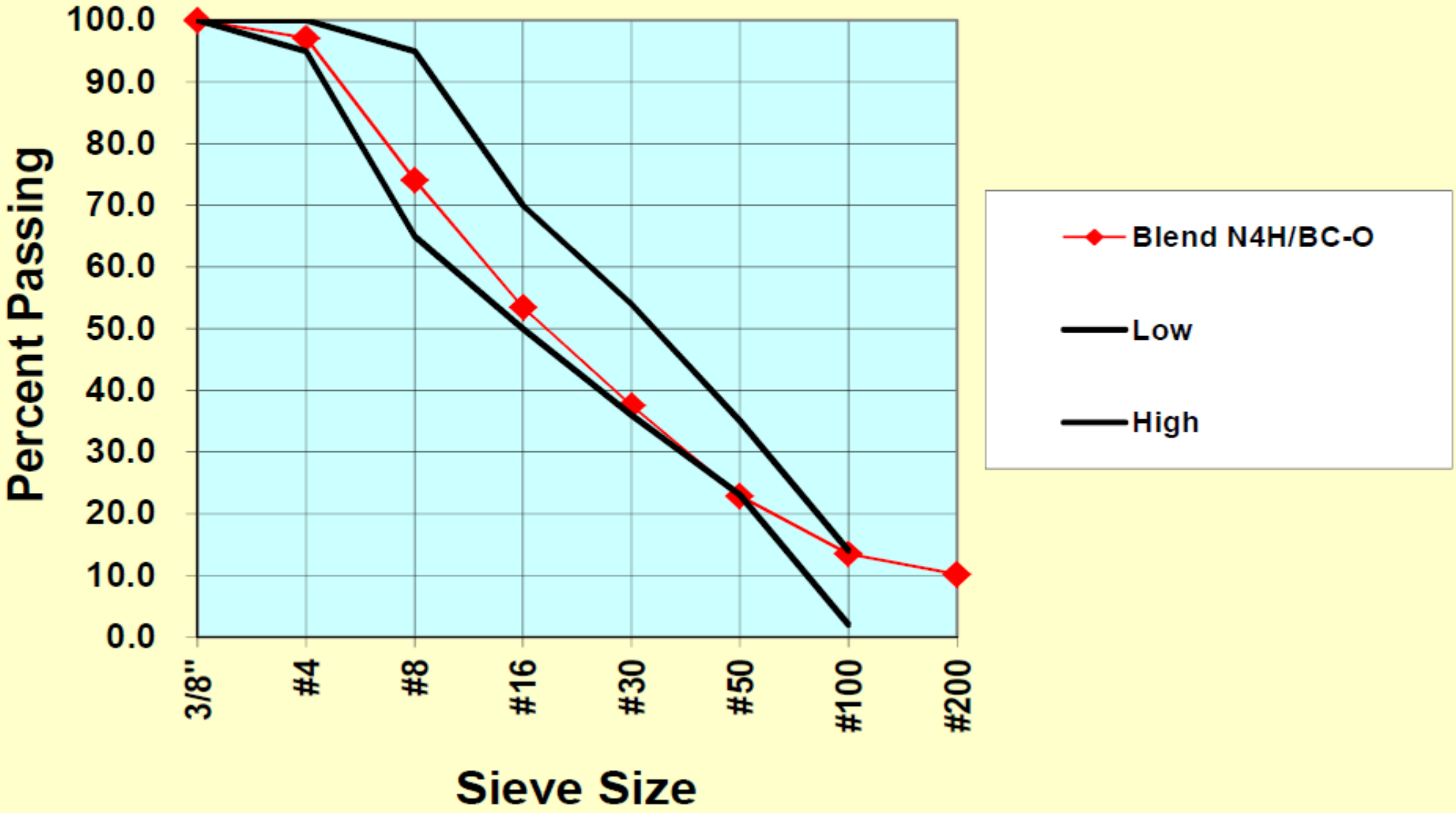
- Three Point Curve for W/CM – Strength Relations using actual break data.
- Add water reducing admixture.
  - Reduces water demand by up to 10%.
- Blend in natural sand.
  - Reduces water demand by 14 pounds (footnote on ACI 211.1R Table 6.3.3) [35# X .40 = 14#].
  - Lowers combined FM to 3.0.


Strength vs. W/C Ratio
Compressive Strength (psi)
7000
6000
5000
4000
3000
2000
0.35
0.45
0.55
0.65
W/C Ratio
DESIGN: 4,500 PSI
W/C: 0.52
AVE: 5,700 PSI

Sieve Analysis - HDOT 703 Concrete Sand



Sieve Analysis - HDOT 703 Concrete Sand



Modified Aggregate Blend

MATERIAL		MIX UNITS	MIX PORTIONS	SP.GR.	WEIGHT (LBS.)	ABSOLUTE VOLUME (CU.FT.)
CEMENT		SACKS	6.0	3.15	564	2.869
WATER		GALLONS	35.0	1.00	292	4.678
AIR		PERCENT	2.0	---	---	0.540
3FW		PERCENT	49.6	2.65	1555	9.404
#4H		PERCENT	32.8	2.65	1027	6.211
BC Sand-O		PERCENT	17.6	2.69	553	3.294
Pozz 322N	5	OZ/CY	28.2	---	---	---
TOTAL			---	---	3991	26.996
UNIT WEIGHT(DESIGN)=			147.8	LBS./CU.FT.		
W/CM RATIO (DESIGN)=			0.52			

Sieve	3CH Coarse Aggregate 1 Cumulative Percent Passing	3CH Coarse Aggregate 1 Indiv. Percent Retained	3FW Coarse agg. 2 Cumulative Percent Passing	3FW Coarse agg. 2 Indiv. Percent Retained	3/8H Intermediate agg. Cumulative Percent Passing	3/8H Intermediate agg. Indiv. Percent Retained	#4H Fine Aggregate 1 Cumulative Percent Passing	#4H Fine Aggregate 1 Indiv. Percent Retained	N4S Fine Aggregate 2 Cumulative Percent Passing	N4S Fine Aggregate 2 Indiv. Percent Retained	BC Sand-O Fine Aggregate 3 Cumulative Percent Passing	BC Sand-O Fine Aggregate 3 Indiv. Percent Retained
1 1/2"	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
1"	88.6	11.42	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
3/4"	38.9	49.72	99.8	0.20	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
1/2"	6.9	31.97	65.9	33.90	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
3/8"	4.3	2.61	36.8	29.10	97.1	2.86	100.0	0.00	100.0	0.00	100.0	0.00
#4	1.9	2.36	9.1	27.70	8.1	89.03	97.1	2.90	95.0	5.00	96.9	3.10
#8	1.5	0.39	5.3	3.80	2.7	5.41	69.3	27.80	71.0	24.00	80.5	16.40
#16	1.2	0.31	5.3	0.00	2.0	0.67	45.3	24.00	51.2	19.80	65.6	14.90
#30	0.9	0.28	5.3	0.00	1.6	0.39	30.2	15.10	34.9	16.30	49.0	16.60
#50	0.8	0.17	5.3	0.00	1.3	0.39	21.1	9.10	16.2	18.70	24.8	24.20
#100	0.5	0.26	5.3	0.00	0.9	0.40	16.4	4.70	4.5	11.70	7.6	17.20
#200	0.2	0.30	1.0	4.30	0.5	0.40	13.9	2.50	1.7	2.80	2.2	5.40
FM	7.61		6.28		5.86		3.21		3.27		2.76	

SIX AGGREGATE BLEND

		TOTAL AGG BLEND	
	3CH	0.0%	0 Lbs.
	3FW	49.6%	1555 Lbs.
FINE AGG BLEND	3/8H	0.0%	0 Lbs.
65.00%	#4H	32.8%	1027 Lbs.
0.00%	N4S	0.0%	0 Lbs.
35.00%	BC Sand-O	17.6%	553 Lbs.
3.05 FM			
	Total=	100.0%	3135 Lbs.

Coarseness Factor (CF) = 51.8

Workability Factor (W) = 39.5

Corrected = 39.5 4.65 Total FM

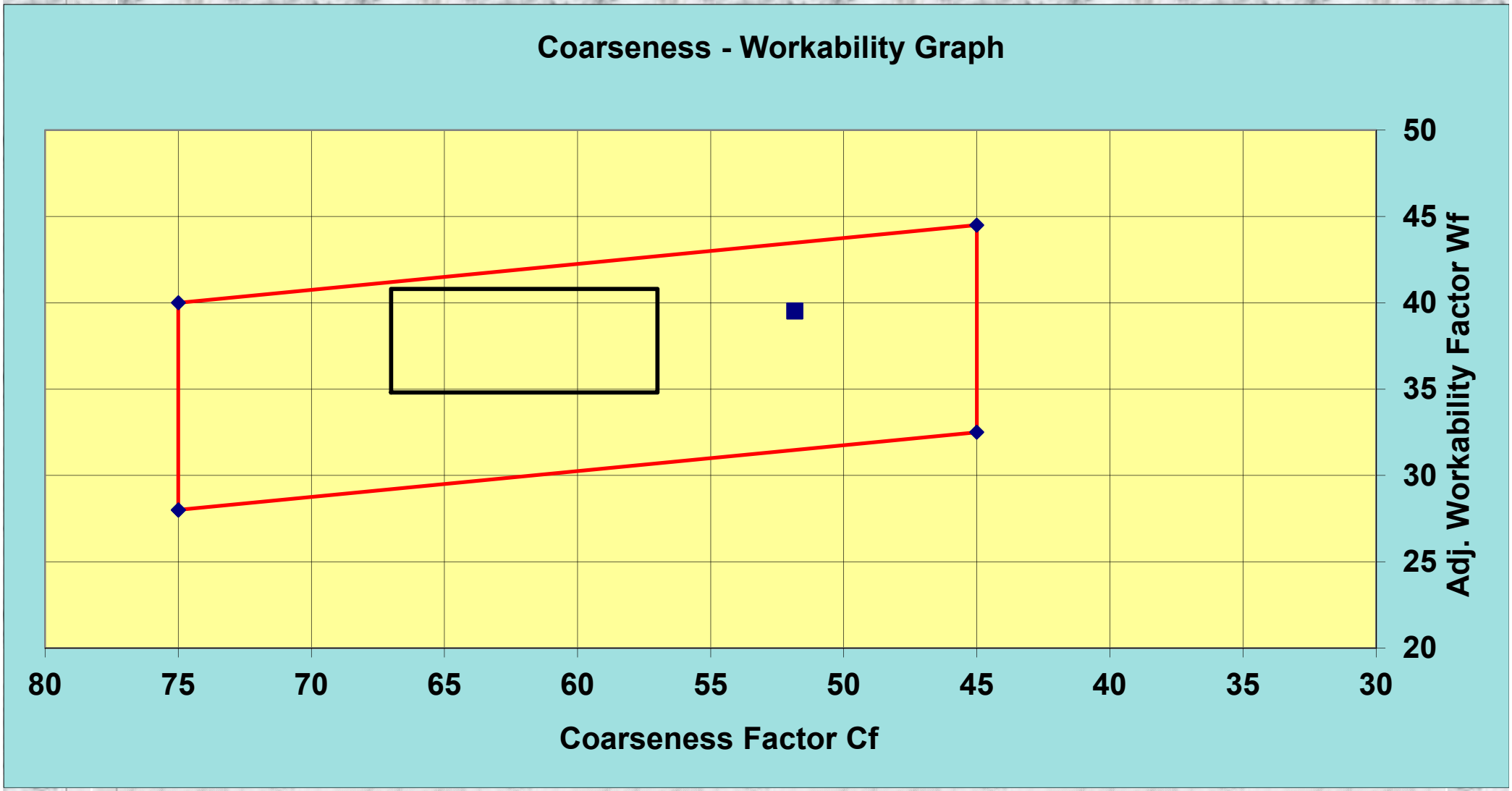
Sieve	Blend % Passing	Indiv. Percent Retained	Cumulative Percent Retained
1 1/2"	100.0	0.0	0.0
1"	100.0	0.0	0.0
3/4"	99.9	0.1	0.1
1/2"	83.1	16.8	16.9
3/8"	68.7	14.4	31.3
#4	53.4	15.2	46.6
#8	39.5	13.9	60.5
#16	29.0	10.5	71.0
#30	21.2	7.9	78.8
#50	13.9	7.2	86.1
#100	9.3	4.6	90.7
#200	5.4	3.9	94.6

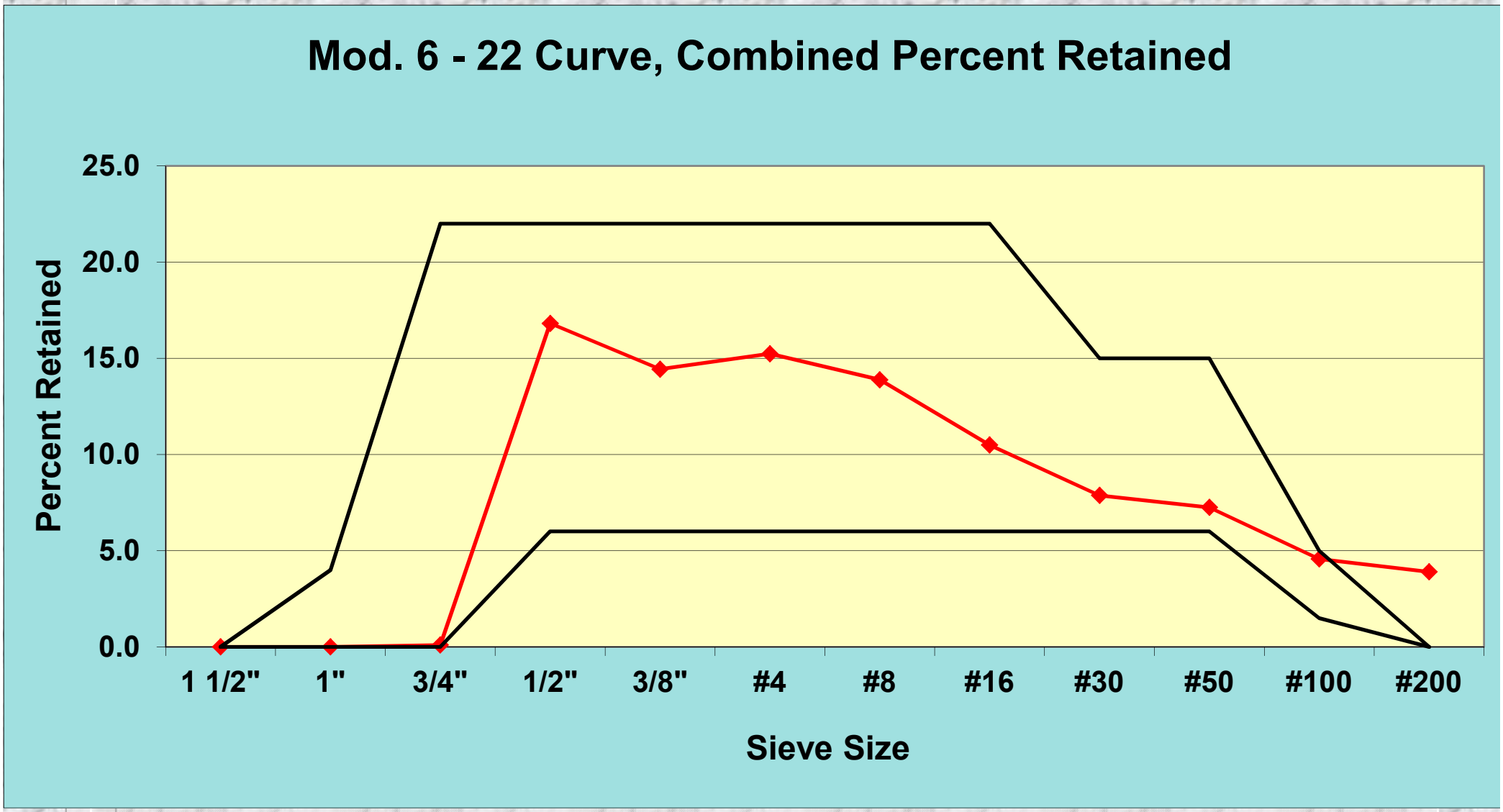
Sieve	3CH Coarse Aggregate 1 Cumulative Percent Passing	3CH Coarse Aggregate 1 Indiv. Percent Retained	3FW Coarse agg. 2 Cumulative Percent Passing	3FW Coarse agg. 2 Indiv. Percent Retained	3/8H Intermediate agg. Cumulative Percent Passing	3/8H Intermediate agg. Indiv. Percent Retained	#4H Fine Aggregate 1 Cumulative Percent Passing	#4H Fine Aggregate 1 Indiv. Percent Retained	N4S Fine Aggregate 2 Cumulative Percent Passing	N4S Fine Aggregate 2 Indiv. Percent Retained	BC Sand-O Fine Aggregate 3 Cumulative Percent Passing	BC Sand-O Fine Aggregate 3 Indiv. Percent Retained
1 1/2"	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
1"	88.6	11.42	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
3/4"	38.9	49.72	99.8	0.20	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
1/2"	6.9	31.97	65.9	33.90	100.0	0.00	100.0	0.00	100.0	0.00	100.0	0.00
3/8"	4.3	2.61	36.8	29.10	97.1	2.86	100.0	0.00	100.0	0.00	100.0	0.00
#4	1.9	2.36	9.1	27.70	8.1	89.03	97.1	2.90	95.0	5.00	96.9	3.10
#8	1.5	0.39	5.3	3.80	2.7	5.41	69.3	27.80	71.0	24.00	80.5	16.40
#16	1.2	0.31	5.3	0.00	2.0	0.67	45.3	24.00	51.2	19.80	65.6	14.90
#30	0.9	0.28	5.3	0.00	1.6	0.39	30.2	15.10	34.9	16.30	49.0	16.60
#50	0.8	0.17	5.3	0.00	1.3	0.39	21.1	9.10	16.2	18.70	24.8	24.20
#100	0.5	0.26	5.3	0.00	0.9	0.40	16.4	4.70	4.5	11.70	7.6	17.20
#200	0.2	0.30	1.0	4.30	0.5	0.40	13.9	2.50	1.7	2.80	2.2	5.40
FM	7.61		6.28		5.86		3.21		3.27		2.76	

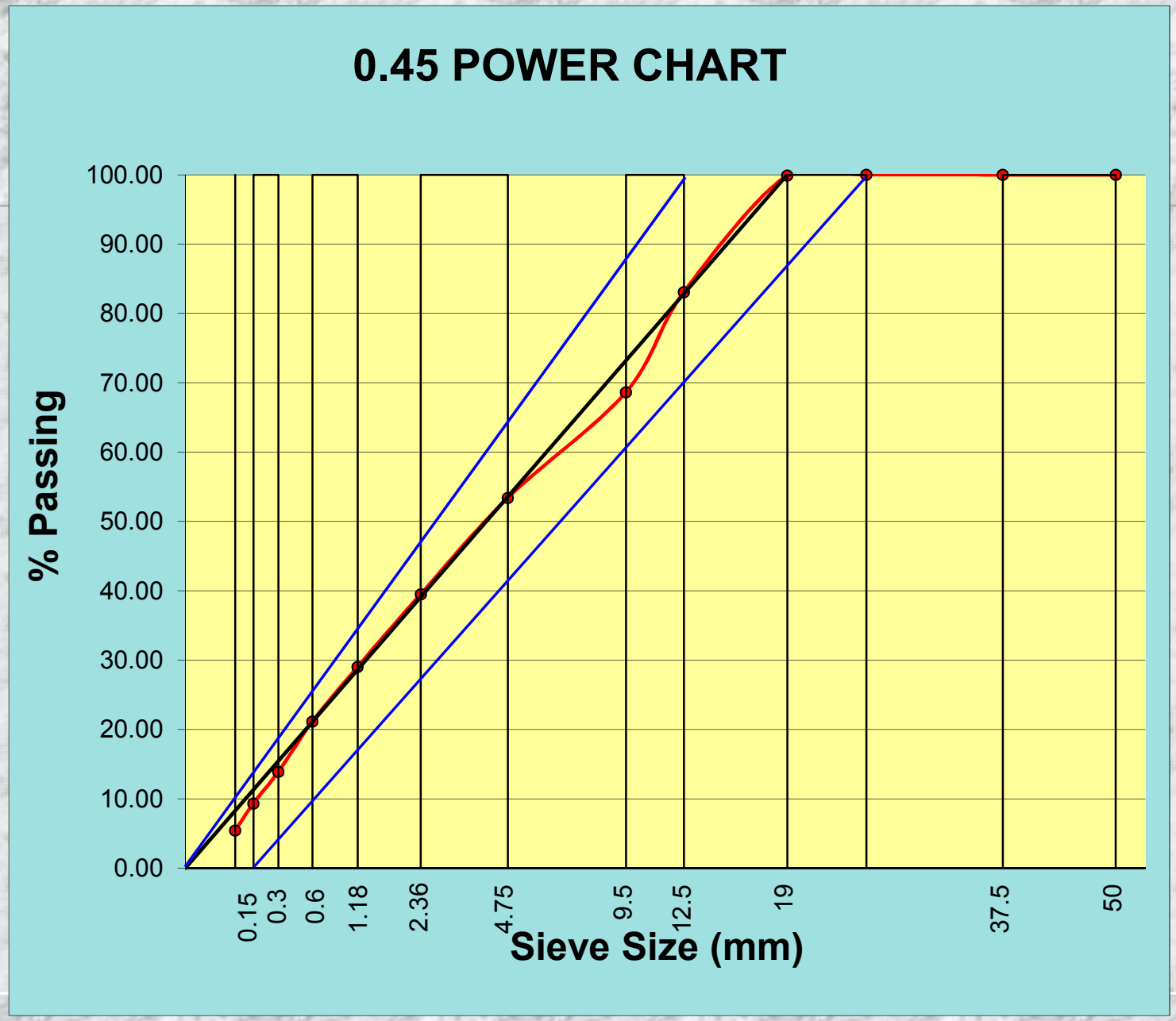
SIX AGGREGATE BLEND

		TOTAL AGG BLEND	
	3CH	0.0 %	0 Lbs.
	3FW	49.6 %	1555 Lbs.
FINE AGG BLEND	3/8H	0.0 %	0 Lbs.
65.00%	#4H	32.8 %	1027 Lbs.
0.00%	N4S	0.0 %	0 Lbs.
35.00%	BC Sand-O	17.6 %	553 Lbs.
3.05 FM			
	Total=	100.0 %	3135 Lbs.
	Coarseness Factor (CF)	51.8	
	Workability Factor (W) =	39.5	
	Corrected =	39.5	4.65 Total FM

Sieve	Blend % Passing	Indiv. Percent Retained	Cumulative Percent Retained
1 1/2"	100.0	0.0	0.0
1"	100.0	0.0	0.0
3/4"	99.9	0.1	0.1
1/2"	83.1	16.8	16.9
3/8"	68.7	14.4	31.3
#4	53.4	15.2	46.6
#8	39.5	13.9	60.5
#16	29.0	10.5	71.0
#30	21.2	7.9	78.8
#50	13.9	7.2	86.1
#100	9.3	4.6	90.7
#200	5.4	3.9	94.6


Coarseness - Workability Graph
50
45
40
35
30
25
20
Adj. Workability Factor Wf
80
75
70
65
60
55
50
45
40
35
30
Coarseness Factor Cf


Mod. 6 - 22 Curve, Combined Percent Retained
Percent Retained
25.0
20.0
15.0
10.0
5.0
0.0
1 1/2"
1"
3/4"
1/2"
3/8"
#4
#8
#16
#30
#50
#100
#200
Sieve Size


0.45 POWER CHART
% Passing
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.15
0.3
0.6
1.18
2.36
4.75
9.5
12.5
19
37.5
50
Sieve Size (mm)

Mix Proportioning Example

4500-¾” REGULAR (6 sack)

Proportioning Concrete Mixes

- 4” Thick Slab on Grade
- No Freeze Thaw, no deicer
- Specified Strength 4,500 psi
- Non-reinforcement
- No Mix Statistical Data
- 3/4” Crushed Stone, Sp. Gr. = 2.65, Dry-Rodded Unit Weight = 96 pcf
- Blend/Manufactured Sand, Sp. Gr.=2.664, Fineness Modulus = 3.00

Proportioning Concrete Mixes

- $f'_{cr}=f'_c+1{,}200 = 4{,}500+1{,}200=5{,}700$psi (ACI 318-08 Table 5.3.2.2)
- W/C (Table 6.3.4(b))=NA and W/C (Three Point Curve) = 0.52
- 3/4" aggregate $\leq$ 1/3 thick, ~~3/4 distance between bars~~
- Air (Table 6.3.3) = entrapped only (2%)
- Slump (Table 6.3.1) = 1 to 3"
- Water (Table 6.3.3) (340# X 0.90)-12.0 = 294

Proportioning Concrete Mixes

- Cement (292# H_2O/0.52 W/C) = 564 lbs.
- Coarse Aggregate (Table 12-4) 27 X 96 X 0.60 = 1555 lbs.
- Air 2% Entrapped only.
- Sand Make up Remaining Volume.

Proportioning Concrete Mixes

- Sand Estimate
- Water = 292 / (1 X 62.4) = 4.678 Cu.Ft.
- Cement = 564 # / (3.15 X 62.4) = 2.869 Cu.Ft.
- Air = (2.0 / 100) X 27.00 = 0.540 Cu.Ft.
- Coarse Aggregate = 1555# / (2.65 X 62.4) = 9.404 Cu. Ft.
- Sand = 27 – 4.678 - 2.869 - 0.540 - 9.404 = 9.509
- 9.509 X 2.664 X 62.4 = 1581 # Sand

Mix Design

Criteria: 3/4” CA, Dry Rodded Unit Wt = 100 pcf, 2.65 SpGr

FM = 2.80, 2.65 SpGr, 540 pcy, 2% air, Water 340#

Material	Sp.Grav.	Weight/cy	Abs.Vol., cu ft
Cement	3.15	564	2.869
Fly Ash	2.50	0	0
Coarse Agg	2.65	1555	9.404
Fine Agg	2.667	1581	9.509
Water	1.00	292	4.678
AEA	NA	2.0%	0.540
WR	5 oz/ cwt		
		39002 #	26.999 cu ft

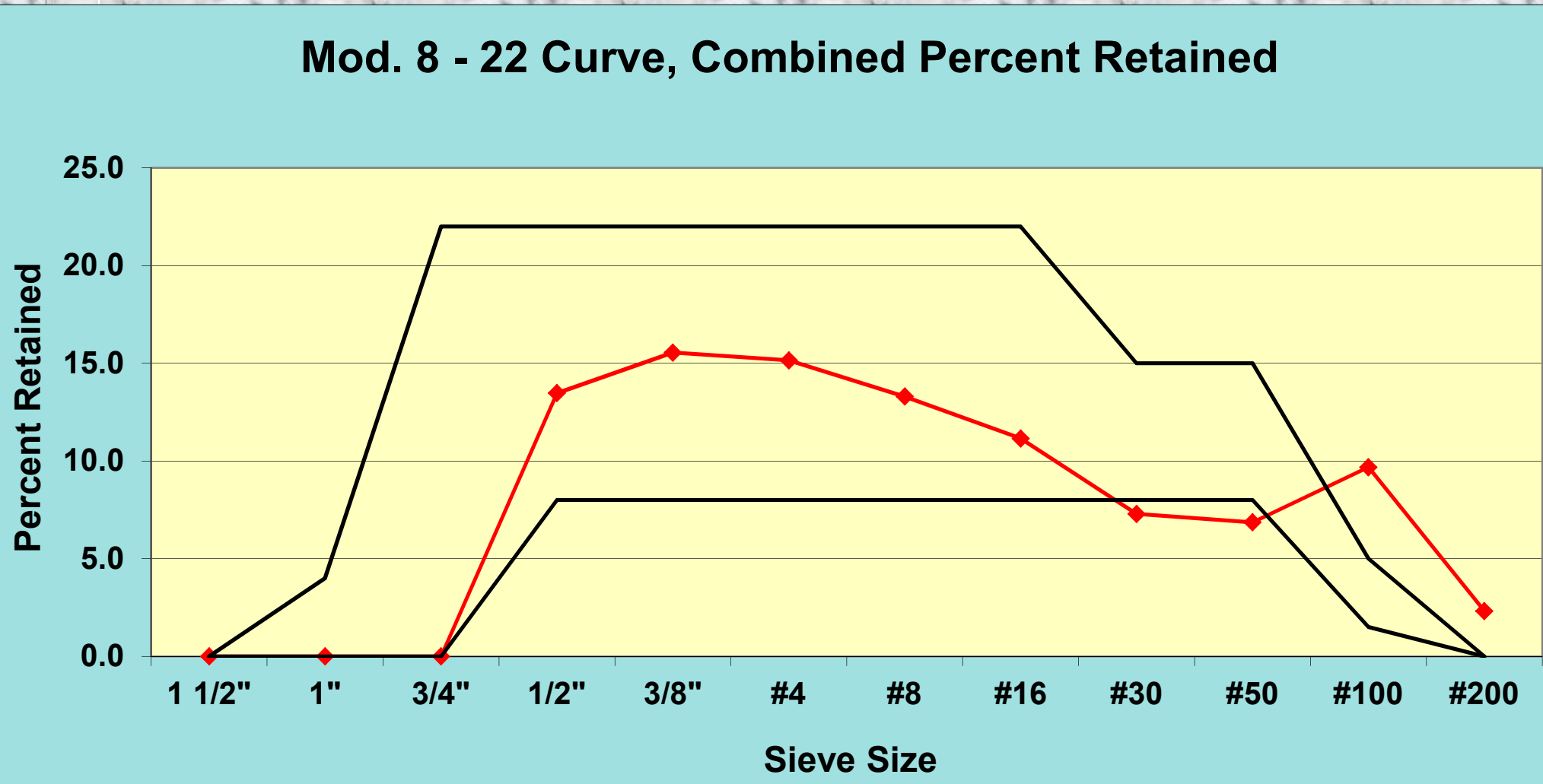
Mix Designs

Outer Islands

Maui: 6sks. ¾” Regular

MATERIAL		MIX UNITS	MIX PORTIONS	SP.GR.	WEIGHT (LBS.)	ABSOLUTE VOLUME (CU.FT.)
CEMENT		SACKS	6.00	3.15	564	2.87
FLY ASH		PERCENT	0.0	2.55	0	0.00
SILICA FUME		PERCENT	0.0	2.20	0	0.00
WATER		GALLONS	37.5	1.00	313	5.02
AIR		PERCENT	1.5	---	---	0.41
3 F		PERCENT	41.5	2.830	1350	7.64
3/8"		PERCENT	7.9	2.810	150	0.86
4 F		PERCENT	41.2	2.786	1341	7.71
SCREENED SAND		PERCENT	12.7	2.668	415	2.49
Pozzolith 322-N	5.50	OZ/CY	31.0	---	---	0.03
Delvo Stabilizer	1.00	OZ/CY	5.6	---	---	0.01
Rheomac VMA-362	1.50	OZ/CY	8.5	---	---	0.01
Glenium 3030-NS	1.50	OZ/CY	8.5	---	---	0.01
TOTAL			---	---	4133	26.99703

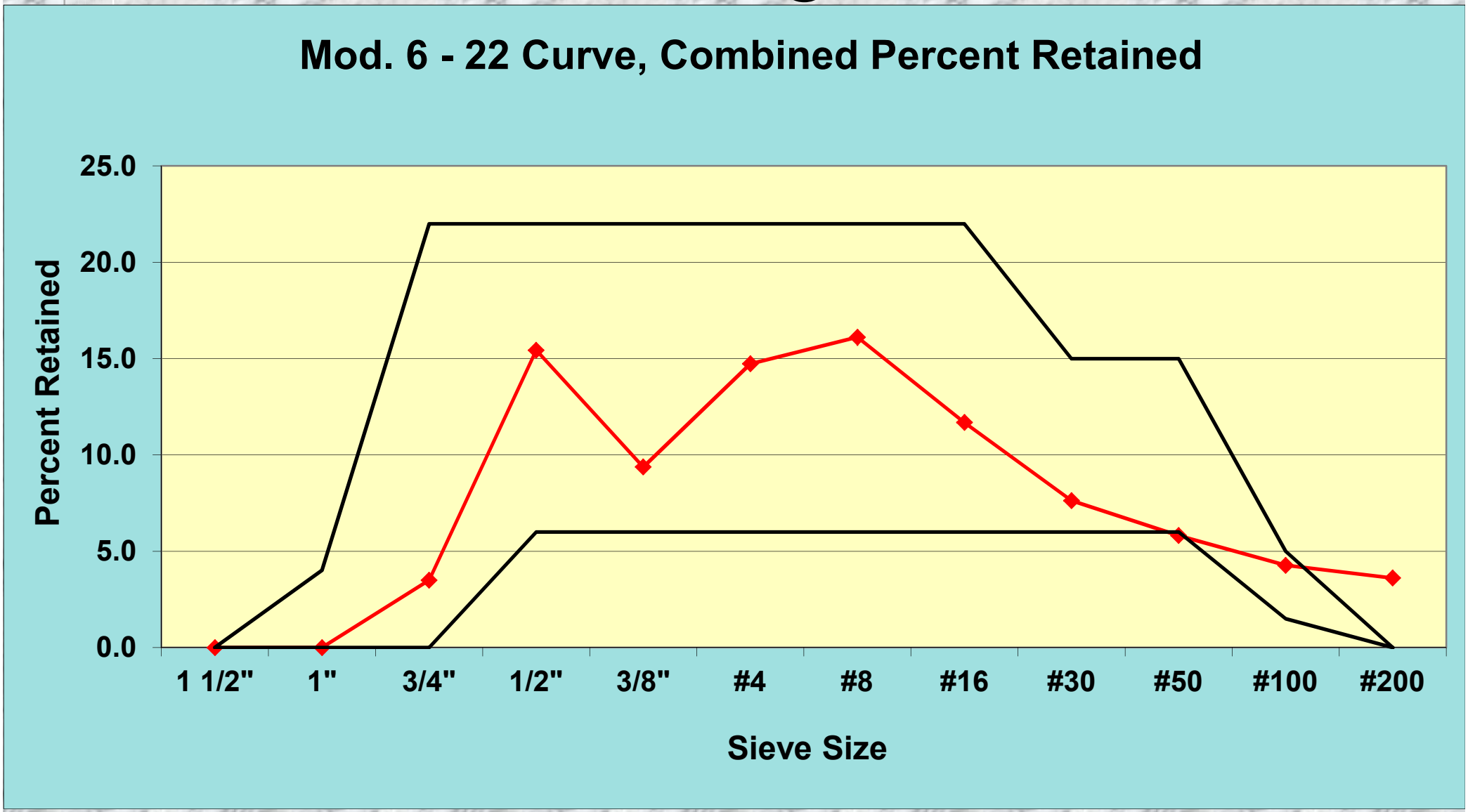
Maui: 6sks. ¾” Regular



WHC: 6sks. ¾” Regular

MATERIAL		MIX UNITS	MIX PORTIONS	SP.GR.	WEIGHT (LBS.)	ABSOLUTE VOLUME (CU.FT.)
CEMENT		SACKS	6.0	3.15	564	2.87
WATER		GALLONS	38.0	1.00	317	5.08
AIR		PERCENT	4.0	---	---	1.08
3FWa		PERCENT	46.6	2.65	1450	8.77
#4HK		PERCENT	53.4	2.90	1659	9.17
Pozz 322N	5	OZ/CY	28.2	---	---	---
TOTAL			---	---	3990	26.96
UNIT WEIGHT(DESIGN)=			148.0	LBS./CU.FT.		
W/CM RATIO (DESIGN)=			0.56			

WHC: 6sks. ¾” Regular




ALOHA

Concrete Proportioning in Hawaii

Questions & Comments

Mahalo (Thank You)!

HAWAIIAN CEMENT