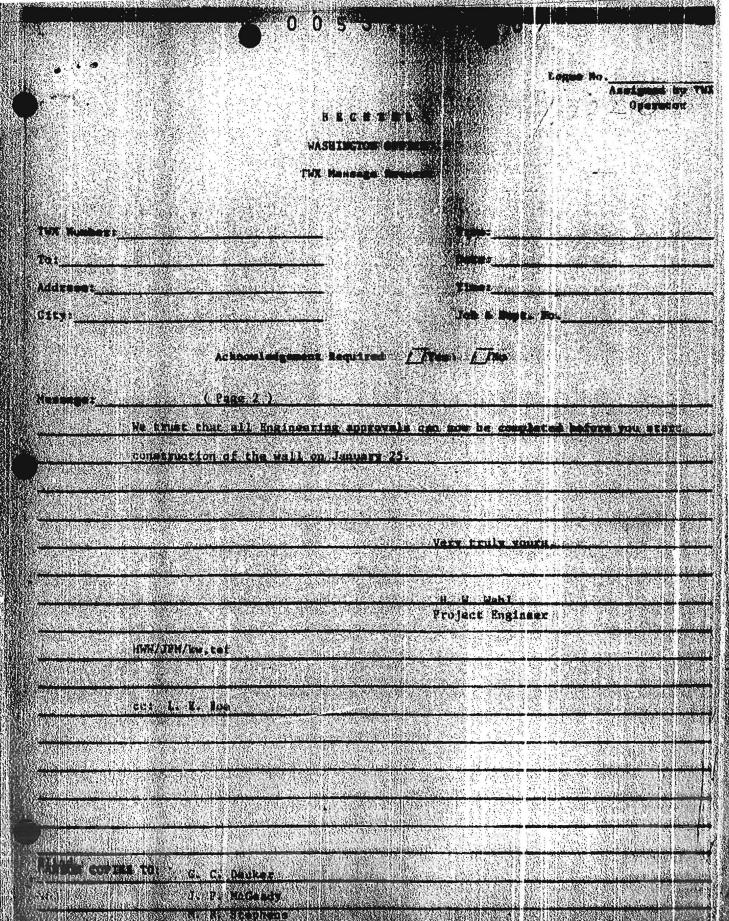


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THE SPICE substation.



RECLES-POWER SERVICE, INC. EMBINEERS - CONSTRUCTORS 2110 NICOLLET AVENUE MINNEAPOLIS, MIRN, 55404

October 23, 1970

Bechtal Company P. O. Box 607 /190 Shady Grove Road Gaithersburg, Maryland 20760

Actontion) Mr. H. W. Wahl, Project Engineer

Genelemen:

xhibit 11

Re: Shield Building Mail Toledo Edison Company Oak Harbor, Onio Lotter No. 21

0 0 5 3 2 1 Cm 6 6 6 8 __

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DC1 2 8 1970

Reference is made to your verbal request of October 22, 1970 for additional information concerning the concrete design mix contained in our letters of October 6, 1970 and October 13, 1970.

We are enclosing a list of test reports that were prepared by Ywln Gity Testing & Engineering Laboratory, Inc. in connection with the design mix for this project. We have attached a summary of the average test cylinder results for your easy reference.

We call your attention to Laboratory Report #6-7789 dated August 27, 1970, which indicates an approximate ratio of 90% compressive strength at 14 days for the freeze-thaw test.

The concrete mix design using Type 1 cement, contained in our letter of October 6, 1970, corresponds to design mix C-2-SF-4 in the laboratory reports. The concrete mix design using Type 2 cement, contained in our latter of October 13, 1970, was arrived at by interpolation from design mix C-2-SF-2.

Yours very truly,

EEGLES POLYR SERVICE, INC.

A salar and

J. J. Ellison, Vice President & Gen. Supt.

JCF.gl #250 Encl. cc: Dechtal. - Onk Harbor W/ancl. Tolado Edison - Onto W/ancl. Field W/ancl. JCF. W/ancl.

	Shield Building Wall	
÷	Toledo Edison Company	
	Oak Harbor, Chio	

SUMMARY TEST CYLINDERS

TYPE 1 CEMENT

Døsign Mix: Slump:	C-2-SF 4"	C-2-SF-4	C-2-SP-3
1 day 2 day	1815	2000	1940
	2360	2740	2620
7 day		3510	3390
28 day	4900	4850	4390

그는 가지 않는 것	TYPE 2	CENENT
Design Mix:	C-2-5F-2	C-2-5F-2
Ślump:	40	5-3/4"
l day 2 day	1500	1300
7 day	1740 3630	1545 3365
28 day	5590	5040



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Martin Second Second

ALC: NO.

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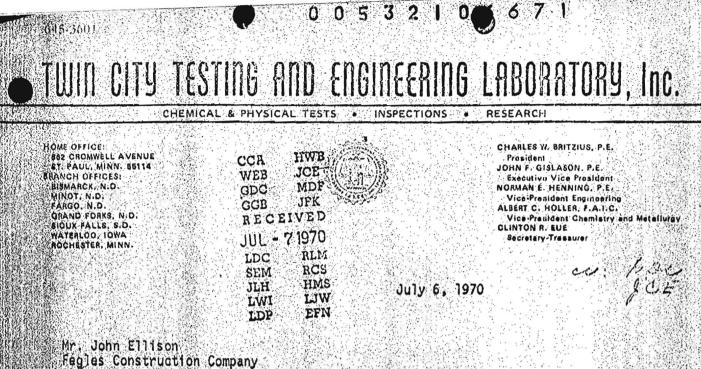
Shield Euilding Wall Toledo Edisch Company Oak Harbor, Ohio

SUMMARY OF LABORATORY TESTS CONCRETE MIX DESIGN

	Laboratory Number		Date		Type of Yest
	Letter (2	pages)	July 6, 1970	о С	
2	8-2207		July 6, 1970	D	Fine Aggregate Cest (Woodville Lime & Chemical Co.)
	8-2207		July 6, 1970	D	Fine Aggregate Mest (White Rock Quarry)
	8-2207		July 6, 1970	0	Coarse Aggregate feat (Woodville Lime & Chemical Co.)
	8-2207 (2	pages)	July 6, 1970	o .	Concrete Mix Design C-2-SF
	8-2207 (2	pages)	July 13, 197	70	Soundness of Fine Aggregate (Woodville Lime & Chemical Co.)
	8-2207 (2	pages)	July 28, 197	70	Concrete Mix Design C-2-SF
	6-7789 (2	pages)	August 27, 1	1970	Concrete Mix Design C-2-SF-2
	6-7789		August 27, 1	1970	Freezing Test of Concrete
	6-7789 (2	pages)	Sept. 10, 19	070	Concrete Mix Design C-2-SF-2
	6-7891 (2	pages)	Oct. 2, 1970	0	Concrete Mix Design C-2-SF-3 and C-2-SF-4
	6-7891 (2	pages)	Oct. 22, 197	70	Concrete Mix Design C-2-SF-3 and C-2-SF-4

10/23/70

NIT 26 1910



Fegles Construction Company 2410 Nicollet Avenue Minneapolis, Minnesota 55404

Dear John:

The results of the tests completed to date on the aggregates for the concrete mix for the slip form at the above project are enclosed. The manufactured sand from the White Rock Quarry was too fine to meet specifications and, therefore, was not used in the concrete mix design. The gradation of the manufactured sand from the Woodville Lime & Chemical Company was satisfactory, and this sand was used in the preparation of the concrete mix design. To date, the tests on the coarse aggregate indicate that this material is of acceptable quality.

The concrete mix design and the 1 and 2 day compressive strengths are also included. The concrete mix utilizing 6 sacks of Type I Portland cement and Master Builders Type 200-N Pozzolith had very satisfactory compressive strength results. This mix had a compressive strength of 1815 psi at 1 day and 2560 psi after 2 days curing. The cylinders were cured in air at the laboratory for the first 48 hours. The ambient temperature at the laboratory was approximately 73 F and the relative humidity was about 50 per cent.

Since the compressive strength of the Type I concrete mix was exceedingly satisfactory, it is not felt necessary to investigate the use of the Type III High Early strength Portland cement in the concrete mixture. From past experience, we would estimate that if Type III Portland cement is used in the mixture, the resultant concrete would have a compressive strength of about 2600 psi after 1 day curing and 3400 psi after 2 days curing.

OT 8 8 1970

TUAL PROVERIGN TO SUCHTS THE PUBLIC AND OURSELVES ALL REPORTS ARE SUSALITED AS THE CONFIDENTIAL PROVENTY OF SUL FOR PUBLICATION OF STATEMENTS CONSLUTIONS OF STRACTS FROM ON REGARDING OUR REPORTS IS SISTING ULTOING OUR

Re: Toledo-Edison Power & Light Toledo, Ohio

Mr. John Ellison Fegles Construction Company July 6, 1970 Page 2

The remaining tests on the aggregate will be reported when completed.

0 0 5 3 2 1 0 4

Very truly yours,

TWIN CITY TESTING AND ENGINEERING LABORATORY, INC.

UET 1: 6 1970

672

R. C. McNamara

RCM/ds Encls. Laboratory No. 8-2207

PROJECT: REPORTED TO: (8)		on Company nue esota 55404	Paul, Minn. 55114 TE TEST DATE: FURNISHED BY:1	July 6, 1970 Noodville Lime & Noodville, Ohio	
LABORATORY N	신수 영상에서 전환하는 것이 없는 것이 없다.				
TYPE OF AGGRE	GATE:	Crushed Limestone	- Manufactured Sa		PROJECT PECIFICATIONS
MECHANICAL AN	IALYSIS:				
# 4 . # 8 . # 16 .			00% 84 51		100% 95+100 70-95 45-80
# 50 . #100 .	цв		30 18 9,8 3.07	2.5-3.1	25-60 10-30 1-10 (Max. Var. +
DELETERIOUS M	ATEBIALS				
		N	one		Maximum 1.0%
Material Finer (han #200	3	.5%		3.0% for cond act to abrasio
Coal and Lig	ticles (Specific Gravity) nite	N N	ona one one	Max. 1.0% (0.5% appearant te is importa
Organic Matter	·····	P	late #1	Plate 3) or Lighter
SOUNDNESS (5 a	vcle MgSO4)	Ť	o be reported late	3 2	Maximum 15%
SPECIFIC GRAV	тү (в.о.р.)	2	.63	가슴에 가슴 (4) - 이번 가슴 (4) - 이번 가슴 (4)	
UNIT WEIGHT: REMARKS: The) (Dry Rodded) a above sample me nent concrete as a	(a) An effective description of the second s second second secon second second sec	.9 03.5 pcf ications for fine submitted to the	aggragata for r laboratory and	ortland received

ANY HUYUAL PROTECTION TO CLIENTS, THE PUBLIC AND OURSELVAS, ALL REPORTS ARE SUBMITTED AS THE CONFIDENTIAL PROPERTY OF CLIENTS, AND AUT

Twin City Testing

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Stranger 1		AND CHEMISTS	6	CT CO
		nue - St. Paul, Minn. 55114		(:)
TOLE	DO-EDISON POWER & LIGHT	GREGATE TEST	July 6, 1970	עם
1015	DO, OHIO es Construction Company		BY: White Rock Quarry	
(8) Minn	Nicollet Avenue eapolis, Minnesota 55404	COPIES TO:		
Attn	Mr. John Ellison			
ABORATORY No. 8				
TYPE OF AGGREGATI	E: Crushed Li	mestone - Manufactu	ASTM	· · · · · · · · · · · · · · · · · · ·
		a daga k	SPECIFIC	ATION
MECHANICAL ANALY	S)S:			
Passing 3/8"		100%	10(95-1	
# 8	89	100% 97	70-9)5
and the second	**************************************	75 54	45-8 25-6	
# 50 #100		36 20	10- 1-1	· · · · · · · · · · · · · · · · · · ·
Fineness Modulus		2.18	2.5-3.1 (Max.	*** *** *** · · · · · · · · · · · · · ·
DELETERIOUS MATER	iialsi			
Friable Particles				2002年1月 1972年1月 1973年1月 1973年1月
Material Finer than #	#200	6.0%	Max. 5.0%(3.0%	
Coal and Lignite . Shale	(Specific Gravity under 2.00)		subject to) adra
Organic Matter				
SOUNDNESS (5 cycle !	MgSO₄)			
SPECIFIC GRAVITY (B.O.D.)			
ABSORPTION (%)	••••	일이 2013년 전체 1913년 - 2017년 - 1913년 - 1913년 1917년 - 1913년 -		100
port	above sample is too fine land cement concrete. Th le was submitted to the 1	erefore, the use of	this sand is not recomme	inded.
	가 있는 것은 것은 것은 것을 수 있다. 1933년 1월 1993년 - 1월 1993년 1월 1993년 1933년 1월 1993년 1월 19			
	병병 이외 - 영영 등 및		OUT CONFIDENTIAL PROPERTY OF CLIENTS, AN ATS IS RESERVED FUNDING, OUR, WAITTEN	8 8 19

		ENGINEERS 2 Cromwell Avenu COARSE AG	AND CHEMISTS us - St. Paul, Minn. 5 GREGATE TEST		
PROJECT: REPORTED TO: F 2 (8) M	OLEDO, OHIO egles Construct 110 Nicollet Av innespolis, Mir ttn: Mr. John	tion Company venue mesota 55404		July 6, 1 HED BY:Woodville TO: Woodville,	Lime & Chemical
LABORATORY No. TYPE OF AGGREGA	8-2207	Crushed Limes	tono		
MECHANICAL ANAL	YSIS:		colle	Composite 40%-60%	PROJECT SPECIFICATIO
Sample Size		1 1/2"-3/4"	3/4"-#4	1 1/2"-#4	1 1/2"-04 3
Passing 2"		100%		100%	100% 95-100
		78	100%	91	-
***		32	90	67	35-70 9
6" · · · · ·		2.1	40	25	. 10-30 2
3/8 114		1.3 1.3	20 2.0	13 1.2	· 10-30 2 0-5
			1.0	0.9	
			6.87	7.18	
DELETERIOUS MAT	BRIALS:				
			None	None	Maximum ()
Soft Particles		0.2%	0.2%	0.2%	Maximum J
Real of the second s	Specific Gravity und	and the second			
Meterial Finer than	#200	None 0 42	None 0.3%	None 0.3%	Maximum 5 Maximum 1
	es (Specific Gravity u				
	1		None	None	Maximum 1
	••••••••••		None	None	
Iron Oxide		None None	NOne None	None None	
IT WEIGHT: (Dry	Rodded)	89.9 pcf	93.4 pcf		
SOUNDNESS (5 oycl			d later		Maximum 1
ABRASION LOSS (L	A.R'A". Grading	0		29.4%	Maximum 5
SPECIFIC GRAVITY	(B.O.D.)	2.69	2.68	2.68 *(1.	0% severe expos
ABSORPTION (%)			1.4	1.3 **(0,	5% appearance 1

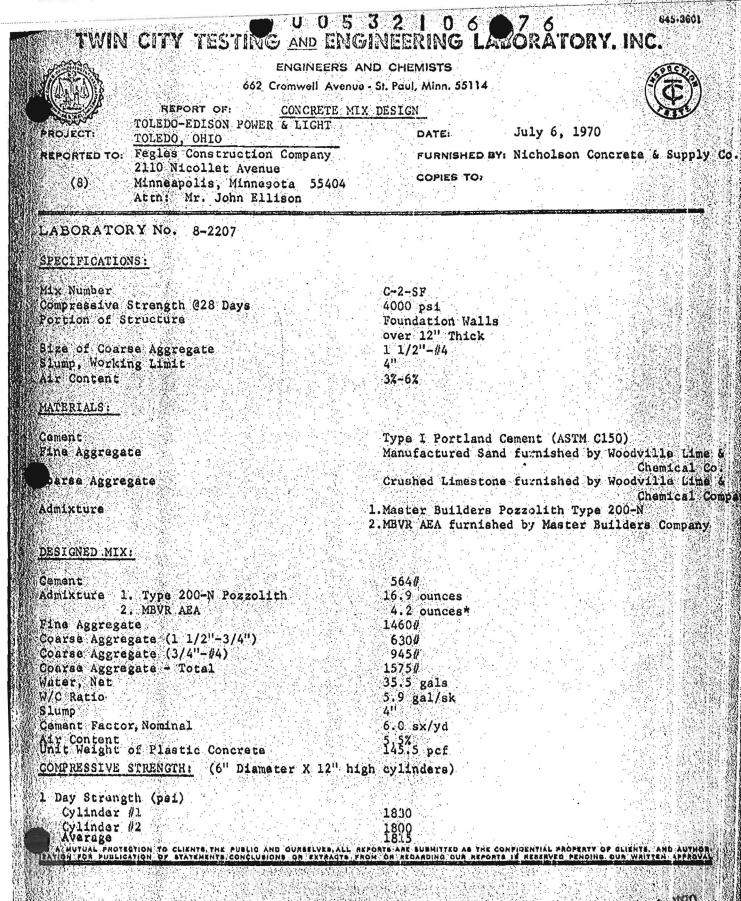
meet quality requirements as shown. The above samples were submitted to the laboratory and received here on June 18, 1970.

Twin City Tetting and Engineering

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AS A HUTUAL PROTECTION YO CLIENTS, THE FURLIC AND OURSELVES ALL HEPORTS ARE SUBMITTED AS THE CONFICENTIAL PROPERTY OF CLIENTS, AND AUTH



EXHIDIL

		MIX DESIGN		DATE:	July 6,	1970	2
ABORATORY No. 8-2207				PAGE:	2 July 0,		
				* *			
		ж					
OMPRESSIVE STRENGTH: (6"	Diameter X 12"	high cylinder.	s) - Conti	nued	·	가지가 있습니다. 1914년 - 1914년 191 1914년 1914년 191	
Day Strength (psi)	× , ·	· · · · ·			· · ·		
Cylinder #3		2520			· .		1.3
Cylinder #4		2600			· · ·		
Average		2560		,			
8 Day_Strength (psi)		To be re	ported lat	er		No state	
Cylinder ∦5	가지 것 한 12년 년 동생님은 14년 12			· · ·			
Cylinder #6							
Average	전 같은 물건		ang na séri				
EMARKS :						1. 注意。2019年 1. 空影 18	
he batch weights shown abo	ve are on an ou	ven dry basis	and should	be adiu	sted for	the amou	unt
moisture in the aggregat							
he compressive strength sp	ecimens were ou	ired in labora	tory air f	n the mo	lds for	the firs	6
8 hours. The ambient temp	Brature Was ADT	roximately 73	oF and the	relativ	e humidi	ty appro	xim

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CUT 8 8 1970

Twin_City Testing and Engineering Laboratory, Inc

TA NUTUAL PROTECTION TO GLIENTS, THE PUBLIC AND OURSELVES, ALL REPORTS ARE SUBMITTED AS THE CONFIDENTIAL PROPERTY OF GLIENTS, AND AUTION TICK FOR PUBLICATION OF STATEMENTS, CONCLUSIONS OR EXTRACTS FACH, OR REGARDING OUR REPORTS IS RESURVED FENDING OUR WHITTEN APPACIAL

PROJECT:		662 Cromwell A SOUNDNESS TH N POWER & LIGHT	RS AND CHEMIST Venue - St. Paul, Minr ST OF FINE AGG DATE	REGATE	ly 13,1970	
REPORTED T	2110 Nicolle Minneapolis, Attn: Mr. J	Minnesota 554			odville Lime & odville, Ohio	Clemical
LABORATORY	Adda a second a second a second		·		<u>, , , , , , , , , , , , , , , , , , , </u>	
SAMPLE IDEN	TIFICATION	Manufactu	red Sand Grushed	Limestone		
METHOD OF	TEST:	ASTM Desi	gnation C88-63	(5 cycle)		
SOLUTION U	SED:	Sodium Su	lfate			
TEST RESULT	rs:			· · · · · · · · · · · · · · · · · · ·		
Sieve Size	Gradation of Original	Test Fraction Before Test (grams)	Test Fraction After Test (grams)	After Test	ing Finer Slave (Actual Loss)	LVeighted Average Loss (%)
Q140						
	Sampio (%)	-		(grams)	(%)	
<u>/8"+#4</u>		100		-	•	-
/8"+#4 #4-#8	Samplo (%)	-	- 94		6	
/8"+#4 #4-#8 #8-#16	Samplo (%) - 16	100		 6 2	•	0,66
/8"+#4 #4-#8 #8-#16 #16-#30	Samplo (%) - 16 33	100	- 94 98 97	 6 2 3	- 6 2 3	<u>0.66</u> .7.63
/8"+#4 #4+#8 #8+#16 #16-#30 #30-#50	Samplo (%) - 16 33 21 12	- 100 100 100	- 94 98	 6 2	6	0.66 2.63
/8"+#4 #4-#8 #8-#16 #16-#30	Samplo (%) 16 33 	- 100 100 100	- 94 98 97	 6 2 3	- 6 2 3	0,66

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0 1970

Inc.

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REMARKS:

In the calculation of the weighted average loss, the sizes smaller than a #50 sizes shall be assumed to have no loss. The soundness loss of this material meets specifications. This report is an addendum to ours of July 6, 1970. Sample was submitted to the laboratory and received here on June 18, 1970.

Twin City Tosting and Engineering

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AN A MUYUAL PROTECTION TO CLIENTS, THE PUBLIC AND GURERLYES, ALL REPORTS ARE SUBMITTED AS THE COMPIDENTIAL PROFERTY OF GLIENTS, AND AUTHOR, TRANSPORTS OF GLIENTS, AND AUTHOR OF BYATEMENTS, CONCLUSIONS ON BYATEMENTS, OF GLIENTS, AND AUTHOR OF BYATEMENTS, AND AUTHOR OF BYATEMENTS, OF GLIENTS, AND AUTHOR OF BYATEMENTS, AND AUTHOR OF BY AU

PROJECT: REPORTED TO: (8)	TOLEDO-EDISO TOLEDO, OHIO Fegles Const 2110 Nicolle Minneapolis, Attn: Mr. J	ruction t Avenue Minneso	Company ta 5540	p	DATE: URNISHED I OPIES TO:	BY: Woodv:	13, 1970 111e Lime & 111e, Ohio	Chemical
LABORATORY NO SAMPLE IDENTIF METHOD OF TES SOLUTION USED TEST RESULTS:	ICATION: T:		signatic	and 60% 3/		shed Lin	estone	
Steva Siza	Gradation of Original Sample (%)	Test Fra Before (gran	Test	Test Fraction After Test (grams)	A	terial Passing F Ifter Test (Act	usi Loss)	Weighted Averlige Lose (%)
1 1/2 ¹¹ -3/4"	33.0	1518		1518	(gran O	ns)	(%)	0.00
3/4"-3/8"	56.6	1000		998	2		0.2	0.11
3/8"-#4	10.4	300		298	2		0.7	0.07
Totels	100.0	2818		2814	4			0.18
EXAMINATION C Slave Fraction		ARGER TH			Number of P Creckad	articles Aft in T	fest	Total
1 1/2"-3/4"	50		0	0	3	0	55	58-
61 81	ne weighted a lbmitted samp idendum to ou sceived here	les. The rs of Ju	soundne ly 6, 19	as loss med 70. Sampla	ts specif	ications	This rep	ort is an

	RS AND CHEMISTS
I CE MO IN	
TOLEDO-EDISON POWER & LIGHT	E MIX DESIGN
ROJECT: TOLEDO, OHIO	DATE: July 28, 1970
REPORTED TO: Fegles Construction Company 2110 Nicollet Avenue	FURNISHED BY: Nicholson Concrete & Suppl
(8) Minneapolis, Minnesota 5540	D4 COPIES TO:
Attn: Mr. John Ellison	
ABORATORY No. 8-2207	
PECIFICATIONS:	- 2011년 1월 11일 - 11일 - 11일 - 11 - 11일 - 11
11x Number	C-2-SF
Compressive Strength @28 Days	4000 psi
Ortion of Structure	Foundation Walls
lize of Coarse Aggregate	over 12" Thick 1 1/2"-#4
lump, Working Limit	4"
Air Content	3%-6%
ATERIALS:	
ament	Type I Portland Cement (ASTM C150)
ine Aggregate	Manufactured Sand furnished by Woodvilla Lim
	. Chemical
loarse Aggregate	
dmixture	
	Chemical 1.Master Builders Pozzolith Type 200-N
dmixture	Chemical 1.Master Builders Pozzolith Type 200-N
Amixture <u>DESIGNED MIX:</u>	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan
Admixture <u>DESIGNED MIX:</u> Nement	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan 564#
Admixture <u>DESIGNED MIX:</u> Mement Admixture 1, Type 200-N Pozzolith	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces
Admixture <u>DESIGNED MIX:</u> Jement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460#
Admixture DESIGNED MIX: Gement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4")	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630#
Admixture DESIGNED MIX: Ament dmixture 1. Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4)	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945#
Admixture DESIGNED MIX: Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Mater, Net	Chemical 1. Master Builders Pozzolith Type 200-N 2. MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals
Admixture DESIGNED MIX: Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Mater, Nat	Chemical 1. Master Builders Pozzolith Type 200-N 2. MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk
Admixture DESIGNED MIX: Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Mater, Nat //C Ratio Lump	2.MEVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk 4"
Admixture DESIGNED MIX: Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Mater, Nat //C Ratio Lump Dement Factor, Nominal	Chemical 1. Master Builders Pozzolith Type 200-N 2. MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk 4" 6.0 sx/yd
Admixture DESIGNED MIX: Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Vater, Nat V/C Ratio Lump Memant Factor, Nominal 1r Content nit Weight of Plastic Concrate	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk 4" 6.0 sx/yd 5.5% 145.5 pcf
Admixture DESIGNED MIX: Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Mater, Nat //C Ratio Lump Dement Factor, Nominal	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk 4" 6.0 sx/yd 5.5% 145.5 pcf
Admixture DESIGNED MIX: Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Vater, Nat V/C Ratio Lump Memant Factor, Nominal 1r Content nit Weight of Plastic Concrate	Chemical 1.Master Builders Pozzolith Type 200-N 2.MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk 4" 6.0 sx/yd 5.5% 145.5 pcf
Admixture <u>ESIGNED MIX:</u> Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA Ind Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Jater, Nat //C Ratio Lump Rement Factor, Nominal ir Content Init Weight of Plastic Concrete <u>ONPRESSIVE STRENGTH:</u> (6" Diameter X 12" Day Strength (pei) Cylinder #1	Chemical 1. Mastar Builders Pozzolith Type 200-N 2. MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk 4" 6.0 sx/yd 5.5% 145.5 pcf high cylinders) 1830
Admixture DESIGNED MIX: Mement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA Ine Aggregate Doarse Aggregate (1 1/2"-3/4") Doarse Aggregate (3/4"-#4) Doarse Aggregate - Total Vorse Aggregate - Total Vater, Net //C Ratio lump Sement Factor, Nominal ir Content nit Weight of Plastic Concrete ComPRESSIVE STRENGTH: (6" Dismeter X 12" Day Strength (psi) Cylinder #1 Cylinder #2	Chemical 1. Mastar Builders Pozzolith Type 200-N 2. MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk 4" 6.0 sx/yd 55% 145.5 pcf high cylinders) 1830
Admixture DESIGNED MIX: Nement dmixture 1, Type 200-N Pozzolith 2. MBVR AEA The Aggregate Dearse Aggregate (1 1/2"-3/4") Dearse Aggregate (3/4"-#4) Dearse Aggregate - Total Ater, Net //C Ratio lump Dement Factor, Nominal ir Content nit Weight of Plastic Concrete COMPRESSIVE STRENGTH: (6" Diameter X 12' Day Strength (pei) Cylinder #1 Cylinder #2 Average Average	Chemical 1. Master Builders Pozzolith Type 200-N 2. MBVR AEA furnished by Master Builders Compan 564# 16.9 ounces 4.2 ounces* 1460# 630# 945# 1575# 35.5 gals 5.9 gal/sk 4" 6.0 sx/yd 5.5% 145.5 pcf "high cylinders) 1830 1830 1815

REPORT	662 Cromwell Avenue - St. Paul, Minn. 55114 OF: CONCRETE MIX DESIGN
	DATE: July 28, 1970
LABORATORY No. 8-220	07 PAGE: 2
COMPRESSIVE STRENGTH:	(6" Diameter X 12" high cylinders) - Continued
2 Day Strength (psi)	
Cylinder #3	2520
	2600
Cylinder #4 Average	2560、111、111、111、111、111、111、111、111、111、1
Average	2560
STRUCT BALL THE STRUCT BALL STRUCT	2560 4850

The batch weights shown above are on an oven dry basis and should be adjusted for the amount of moisture in the aggregates at the time of batching.

The compressive strangth specimens were cured in laboratory air in the molds for the first 48 hours. The ambient temperature was approximately 73°F and the relative humidity approximate 50%. The 28 day specimens were placed in the laboratory fog room at 2 days of age.

Twin

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City Testing cind Engineering Laborator / Inc

The amount of MBVR ABA will have to be varied to maintain the specified air content.

CO

FOR PUBLICATION OF

TOLEDO - EDISON I ROJECT: <u>TOLEDO, OHIO</u>		Minn, 55114 <u>CN</u>	27, 1970
Fegles Construct: 2110 Nicollet Ave Minneapolis, Minn Attn: Mr. John El	enue nesota	FURNISHED BY: Nichols Copies To:	on Concrete Supply
ABORATORY No. 6-7789			
SPECIFICATIONS:		· ·	
Mix Number Compressive Strength @ 28 D Portion of Structure			
	12" T 13"-#		
Size of Coarse Aggregate Slump, Maximum	4 ¹		
Air Content	3% -6	%	
MATERIALS:	1988년 1989년 1월 1989년 1월 1988년 1월 1988년 1988년 1월 1988년 1월 19 1988년 1월 1988년 1월 198		
Coment Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand Crushed Limestone 1. Master Builder	ortland Cement (ASTM C furn. by Woodville Lin furn. by Woodville Lin s Pozzolith Type 200-N by Master Builders Co	me & Chemical Co. me & Chemical Co.
Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand Crushed Limestone 1. Master Builder	furn. by Woodville Li furn, by Woodville Li	me & Chemical Co. me & Chemical Co.
Fine Aggregate Coarse Aggregate	Manufactured Sand Crushed Limestone 1. Master Builder	furn. by Woodville Lin furn. by Woodville Lin s Pozzolith Type 200-N	me & Chemical Co. me & Chemical Co.
Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Poze	Manufactured Sand Crushed Limestone 1. Master Builder 2. MBVR AEA furn. 564# zolith 16.9	furn. by Woodville Lin furn. by Woodville Lin s Pozzolith Type 200-N by Master Builders Co ounces	me & Chemical Co. me & Chemical Co.
Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Poz 2. MBVR AEA Fine Aggregate	Manufactured Sand Crushed Limestone 1. Master Builder 2. MBVR AEA furn. 564# zolith 16.9 3.0 o 1475#	furn. by Woodville Lin furn. by Woodville Lin s Pozzolith Type 200-N by Master Builders Co ounces unces*	me & Chemical Co. me & Chemical Co.
Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Poz 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4")	Manufactured Sand Crushed Limestone 1. Master Builder 2. MBVR AEA furn. 564# zolith 16.9 3.0 o 1475# 620#	furn. by Woodville Lin furn. by Woodville Lin s Pozzolith Type 200-N by Master Builders Co ounces sunces*	me & Chemical Co. me & Chemical Co.
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Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Poz: 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content, Calculated Unit Weight of Plastic Conc DOMPRESSIVE STRENGTH: (6" diam Slump (inches) Air Content (%) Unit Weight (pcf) 1 Day Strength (psi)	Manufactured Sand Crushed Limestone 1. Master Builder 2. MBVR AEA furn. 564# 201ith 16.9 3.0 o 1475# 620# 930# 1550# 36.0 6.0 g 4" 6.0 s 5.5% rete 145.0 meter x 12" high cyli 4" 5.5 145.0	<pre>furn. by Woodville Lin furn. by Woodville Lin s Pozzolith Type 200-N by Master Builders Co ounces unces unces sunces al/sk x/yd) pcf inders) 5 3/ 5.1 145.</pre>	me & Chemical Co. me & Chemical Co. mpany 4" 8

Exhibit 11

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REPORT OF			uo - St. Paul, A		14.		· ·	(Ť(
	<u>c</u>	ONCRETE	MIX DESIGN	1		÷		VIE.
					D	ATE:	August 2	27, 1970
ABORATORY No. 6-7789		· **			P	GE:	2	
2 Day Strength (psi)								
Cylinder 3		1760		×		1520		
4		1720				1570		
Average		1740				1545		
7 Day Strength (psi)								
Cylinder 5		3580		•••		3320		
6 Average		3680 3630		<u></u>		3410 3365	i i Posta	
AVGAC5C		3030				0000		

REMARKS :

The batch weights shown above are on an oven dry basis and should be adjusted for the amount moisture in the aggregates at the time of batching.

The compressive strength specimens were cured in the laboratory air in the molds for the first hours. The ambient temperature has approximately 73 F and the relative humidity about 50%. The specimens for 7 day and 28 day tests were moist cured after 2 days until tested.

The emount of MBVR AEA will have to be varied to maintain the specified air content.

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1970

festing and Engineering Laboratory,

Exhibit 11

Exhibit 11	CITY TESTING AND ENGINEERING LABORATORY. INC.	The second s
	ENGINEERS AND CHEMISTS 662 Cromwell Avenue - St. Paul, Minn. 55114 REPORT OF: FREEZING TEST OF CONCRETE	
PROJECT:	TOLEDO - EDISON POWER AND LIGHTDATE:August 27, 1970TOLEDO, OHIOFURNISHED BY:Fegles Construction CompanyFURNISHED BY:	というこうで あし 一気
	2110 Nicollet Avenue COPIES TO, Minnespolis, Minnesota Attn: Mr. John Ellison	Salar and and a subser

LABORATORY No.6-7789

GENERAL:

Two cylinders were subjected to freezing when the concrete had reach approximately 1900 os1. The cylinders were cured in the molds the laboratory air at approximately 73 F and 50% relative humidity for 3 days. After 3 days the cylinders were removed from the molds and sealed in a plastic bag and place in a freezer at 0 F for 2 days. After 2 days, the cylinders were removed from the freezer and placed in the laboratory fogroom until 14 days of age. Compressive strength was determined on these cylinders as well as on two companion cylinders which had not been subjected to freezing but had been moist cured after the initial 3 days of air storage.

CONCRETE DATA:

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COMPRESSIVE STRENGTH OF 14 DAYS:

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	RS AND CHEMISTS venue - St. Paul, Minn. 55114	E.	T
	TE MIX DESICN		21
TOLEDO - EDISON POWER AND ROJECT: <u>TCLEDO, OHIO</u>	DATE:	September 10, 1970	42/
REPORTED TO: Fegles Construction Compare 2110 Nicollet Avenue Minneapolis, Minnesota Attn: Mr. John Ellison	NY FURNISHED BY Copies to:	Nicholson Concrete	Suppl
ABORATORY No. 6-7789			
SPECIFICATIONS:			
Mix Number	C-2-SF-2		
Compressive Strength @ 28 Days	4000 psi		
Portion of Structure	Foundation Walls ove	# 日白 初期 [4]	
Size of Coarse Aggregate	12" thick 13"-#4		
Slump, Maximum	4 ¹		
Air Content	3% - 6%		
MATERIALS :			
Cement	a Type II Portland Cement		
Cement Medus Fine Aggregate Manuf	actured Sand furn. by Woo	dville Lime & Chemica	
Fine Aggregate Manuf Coarse Aggregate Crush	actured Sand furn. by Woo ed Limestone furn. by Woo	dville Lime & Chemica dville Lime & Chemica	
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Cement Medus Fine Aggregate Manuf. Coarse Aggregate Crush Admixture 1. Ma 2. MB DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content, Calculated	actured Sand furn. by Woo ed Limestone furn. by Woo ster Builders Pozzolith T VR AEA furn. by Master Bu 564# 16.9 ounces 3,0 ounces* 1475# 620# 930# 1550# 36.0 gals 6.0 gals 6.0 gal/sk 4" 6.0 sx/yd 5.5%	odville Lime & Chemica odville Lime & Chemica Cype 200-N	
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Cement Medus Fine Aggregate Manuf. Coarse Aggregate Crush Admixture I. Ma 2, MB DESIGNED MIX: Gement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content, Calculated Unit Weight of Plastic Concrete COMPRESSIVE STRENGTH: (6" diameter x 1	actured Sand furn. by Woo ed Limestone furn. by Woo ster Builders Pozzolith T VR AEA furn. by Master Bu 564# 16.9 ounces 3.0 ounces 3.0 ounces 1475# 620# 930# 1550# 36.0 gals 6.0 gal/sk 4" 6.0 sx/yd 5.5% 145.0 pcf 2" high cylinders)	dville Lime & Chemica dville Lime & Chemica ype 200-N hilders Company	
Cement Medus Fine Aggregate Manuf. Coarse Aggregate Crush Admixture 1. Ma 2. MB DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content, Calculated Unit Weight of Plastic Concrete COMPRESSIVE STRENGTH: (6" diameter x 1 Slump (inches)	actured Sand furn. by Woo ed Limestone furn. by Woo ster Builders Pozzolith T VR AEA furn. by Master Bu 564# 16.9 ounces 3,0 ounces* 1475# 620# 930# 1550 36.0 gals 6.0 gals 6.0 gal/sk 4" 6.0 sx/yd 5.5% 145.0 pcf	odville Lime & Chemica odville Lime & Chemica Cype 200-N	
Cement Medus Fine Aggregate Manuf. Coarse Aggregate Crush Admixture I. Ma 2, MB DESIGNED MIX: Gement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (12"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Gement Factor, Nominal Air Content, Calculated Unit Weight of Plastic Concrete COMPRESSIVE STRENGTH: (6" diameter x 1	actured Sand furn. by Woo ed Limestone furn. by Woo ster Builders Pozzolith T VR AEA furn. by Master Bu 564# 16.9 ounces 3.0 ounces 3.0 ounces 1475# 620# 930# 1550# 36.0 gals 6.0 gal/sk 4" 6.0 sx/yd 5.5% 145.0 pcf 2" high cylinders) 4"	odville Lime & Chemica odville Lime & Chemica Dype 200-N Milders Company 5 3/4"	
Cement Medus Fine Aggregate Manuf. Coarse Aggregate Crush Admixture 1. Mai 2. MB DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content, Calculated Unit Weight of Plastic Concrete COMPRESSIVE STRENGTH: (6" diameter x 1 Slump (inches) Air Content (%) Unit Weight (pcf)	actured Sand furn. by Woo ed Limestone furn. by Woo ster Builders Pozzolith T VR AEA furn. by Master Bu 564# 16.9 ounces 3.0 ounces 3.0 ounces* 1475# 620# 930# 1550# 36.0 gals 6.0 gal/sk 4" 6.0 sx/yd 5.5% 145.0 pcf 2" high cylinders) 4" 5.5	5 3/4" 5.1	
Cement Medus Fine Aggregate Manuf. Coarse Aggregate Crush Admixture 1. Ma 2. MB DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Nater, Net N/C Ratio Slump Cement Factor, Nominal Air Content, Calculated Unit Weight of Plastic Concrete COMPRESSIVE STRENGTH: (6" diameter x 1 Slump (inches) Air Content (%)	actured Sand furn. by Woo ed Limestone furn. by Woo ster Builders Pozzolith T VR AEA furn. by Master Bu 564# 16.9 ounces 3.0 ounces 3.0 ounces* 1475# 620# 930# 1550# 36.0 gals 6.0 gal/sk 4" 6.0 sx/yd 5.5% 145.0 pcf 2" high cylinders) 4" 5.5	5 3/4" 5.1	

AT A MUTUAL PROTECTION TO GLIENTS, THE PUBLIC AND GURBELVES, ALL REPORTS ARE SUBMITTED AS THE CONFIDENTIAL PROPERTY OF CLIENTS. AND AUTHOR HATION FOR PUBLICATION OF STATEMENTS, CONCLUSIONS OF EXTRACTS FROM OR ARGANDING OUR REPORTS IS RESERVED FERDING OUR WINTEN APPROVA 1900 1

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REPORT OF	ENGINEERS AND CHEMISTS 662 Cromwell Avenue - St. Paul, Minn. 5511 <u>CONCRETE MIX DESIGN</u>	4 .		C.
a a a a a a a a a a a a a a a a a a a		DATE:	September	10,
LABORATORY No. 6-7789		PAGE:	2	
2 Day Strength (psi) .	1760	1520		
N Cylinder 3 4	1730	1570		
Average	1740	1545		
7 Day Strength (psi)				1993) 1993 -
Cylinder 5 6	3580 3680	3320 3410		
Average	3630	3365		
28 Day Strength (psi)				
Cylinder 7	5540 5640	4950 5130	and the second	
o Average	5640 5590	5130		

12.11-1

REMARKS :

The batch weights shown above are on an oven dry basis and should be adjusted for the amount of moisture in the aggregates at the time of batching.

The compressive strength specimens were cured in the laboratory air in the molds for the first 48 hours. The ambient temperature has approximately 73 F and the rolative humidity about 50%. The specimens for 7 day and 28 day tests were moist cured after 2 days until tested.

* The amount of MBVR AEA will have to be varied to maintain the specified air content.

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Twin City Testing and Engineering Laboratory, Inc

A CARRENA AN EP	ERS AND CHEMISTS Avenue - St. Paul, Minn. 55114 VCRETE MIX DESIGN	((Ā))
TOLEDO-EDISON POWER & LI ROJECT: <u>TOLEDO, OHIO</u>	IGHT DATE:	October 2, 1970
EPORTED TO: Fegles Construction Comp 2110 Nicollet Avenue Minneapolis, Minnesota :	FURNISHED	BY: Nicholson Concrete & Supp
(8) Attn: Mr. John Ellison		
ABORATORY No. 6-7891		
SPECIFICATIONS:		
Mix Number	C-2-SF-3	C-2-SF-4
Compressive Strength @ 28 Days Portion of Structure	4000 psi Foundation Walls	4000 psi Foundation Walls
	over 12" Thick	over 12" Thick
Size of Coarse Aggregate	1½"-#4 6"	1≱"-#4 5"
Slump Air Content	3% - 6%	3% - 6%
	시간 이번 것이 같다.	
START START AND A START ST		
Cement	Type I Portland Cement	
Cement Fine Aggregate	Manufactured Sand furn.	. by Woodville Lime & Chemical
	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz	by Woodville Lime & Chemical by Woodville Lime & Chemical zolith Type 200-N
Cement Fine Aggregate Coarse Aggregate	Manufactured Sand furn. Crushed Limestone furn.	by Woodville Lime & Chemical by Woodville Lime & Chemical zolith Type 200-N
Cement Fine Aggregate Coarse Aggregate	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz	by Woodville Lime & Chemical by Woodville Lime & Chemical zolith Type 200-N
Cement Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz	by Woodville Lime & Chemical by Woodville Lime & Chemical zolith Type 200-N
Cement Fine Aggregate Coarse Aggregate Admixture <u>DESIGNED MIX:</u> Cement Admixture 1. Type 200-N Pozzolith	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces	. by Woodville Lime & Chemical . by Woodville Lime & Chemical zolith Type 200-N aster Builders Company 588# 17.6 ounces
Cement Fine Aggregate Coarse Aggregate Admixture DESIGNED MIXI Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 5884 17.6 ounces 3.8 ounces*	. by Woodville Lime & Chemical . by Woodville Lime & Chemical zolith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces*
Cement Fine Aggregate Coarse Aggregate Admixture <u>DESIGNED MIX:</u> Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces	. by Woodville Lime & Chemical . by Woodville Lime & Chemical zolith Type 200-N aster Builders Company 588# 17.6 ounces
Cement Fine Aggregate Coarse Aggregate Admixture <u>DESIGNED MIX:</u> Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4)	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940#	. by Woodville Lime & Chemical . by Woodville Lime & Chemical zolith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940#
Cement Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces 1435# 620# 940# 1560#	. by Woodville Lime & Chemical by Woodville Lime & Chemical zolith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560#
Cement Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces 1435# 620# 940# 1560# 36.5 gals	. by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals ∓- 05
Cement Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces 1435# 620# 940# 1560#	. by Woodville Lime & Chemical by Woodville Lime & Chemical zolith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560#
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Cement Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content	Manufactured Sand furn. Crushed Limestone furn. 1. Master Builders Poz: 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5%	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- 0***** 5.8 gal/sk 5" 6.25 sx/yd 5.7%</pre>
Cement Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Poz: 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 cunces 4.0 cunces* 1440# 620# 940# 1560# 36.0 gals T- or 15 5.8 gal/sk 5" 6.25 sx/yd</pre>
Cement Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Poz: 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- 0***** 5.8 gal/sk 5" 6.25 sx/yd 5.7%</pre>
Cement Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Poz: 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- or 5.8 gal/sk 5" 6.25 sx/yd 5.7% 144.8 pcf</pre>
Cement Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf 12" high Cylinders) 1920	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- or 5.8 gal/sk 5" 6.25 sx/yd 5.7% 144.8 pcf</pre>
Cement Fine Aggregate Coarse Aggregate Admixture ESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content	Manufactured Sand furn. Crushed Limestone furn. 1. Master Builders Poz: 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5%	by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces 4.0 ounces 1440# 620# 940# 1560# 36.0 gals ¥ or 5.8 gal/sk 5" 6.25 sx/yd 5.7%
Cement Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Poz: 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- 0***** 5.8 gal/sk 5" 6.25 sx/yd 5.7%</pre>
Cement Fine Aggregate Coarse Aggregate Admixture DESIGNED MIX: Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content Unit Weight of Plastic Concrete COMPRESSIVE STRENCTH: (6" Diameter x	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Poz: 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- or 5.8 gal/sk 5" 6.25 sx/yd 5.7% 144.8 pcf</pre>
Cement Fine Aggregate Coarse Aggregate Admixture	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf 12" high Cylinders) 1920	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- or 5.8 gal/sk 5" 6.25 sx/yd 5.7% 144.8 pcf</pre>
Cement Fine Aggregate Coarse Aggregate Admixture SIGNED MIX1 Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content Unit Weight of Plastic Concrete OMPRESSIVE STRENCTH: (6" Diameter x 1 Day Strength (psi)	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf 12" high Cylinders)	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- or 5.8 gal/sk 5" 6.25 sx/yd 5.7% 144.8 pcf</pre>
Cement Fine Aggregate Coarse Aggregate Admixture <u>ESIGNED MIX:</u> Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1½"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total Water, Net W/C Ratio Slump Cement Factor, Nominal Air Content Unit Weight of Plastic Concrete <u>COMPRESSIVE STRENGTH:</u> (6" Diameter x 1 Day Strength (psi)	Manufactured Sand furn. Crushed Limestone furn. 1. Master Bullders Pozz 2. MBVR AEA furn. by Ma 588# 17.6 ounces 3.8 ounces* 1435# 620# 940# 1560# 36.5 gals 5.8 gal/sk 6" 6.25 sx/yd 5.5% 145.2 pcf 12" high Cylinders)	<pre>by Woodville Lime & Chemical by Woodville Lime & Chemical colith Type 200-N aster Builders Company 588# 17.6 ounces 4.0 ounces* 1440# 620# 940# 1560# 36.0 gals T- or 5.8 gal/sk 5" 6.25 sx/yd 5.7% 144.8 pcf</pre>

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					DATE:	October	2, 1970
ABORATORY No. 6-7891	•				PAGE:	2	
			• •			а 19 19	
COMPRESSIVE STRENGTH: (6" Di	ameter x 1	2" high	Cylinders) (cont.)		• • •	
2 Day Strength (psi)	б.е Sr						
Cylinder 3		2600			2770		
4 Average		2640		÷	2710 2740		
					2740		
7 Day Strength (psi)			···. ·			• * .	
Cylinder 5		3450 3330			3470		
Average		3390			3550 3510		
							Sec. 3

REMARKS :

The batch weights shown above are on an oven dry basis and should be adjusted for the amount. of moisture in the aggregates at the time of batching.

The compressive strength specimens were cured in laboratory air on the molds for the first 48 hours. The ambient temperature was approximately 73 F and the relative humidity approximate 50%. The 28 day specimens were placed in the laboratory fog room at 2 days of age.

* The amount of MBVR AEA will have to be varied to maintain the specified air content.

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Twin City Testing and Engineering Laboratory, Inc

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662 Cromwell Av	DATE: October FURNISHED BY:)	22, 1970 Nicholson Concrete & Suppl
LABORATORY No. 6-7891		
SPECIFICATIONS:		
Mix Number Compressive Strength @ 28 Days Portion of Structure	C-2-SF-3 4000 psi Foundation Walls over 12" Thick	C-2-SF-4 4000 psi Foundation Walls over 12" Thick
Size of Coarse, Aggregate Slump Air Content	1 1/2" -#4 6" 3%-6%	1 1/2" -#4 5" 3%-6%
MATERIALS :		
Cement Pine Aggregate	Type I Portland Cement Manufactured Sand furn	(ASTM C150) ished by Woodville Lime & Chemical Co.
çõ arae Aggregate	Crushed Limestone furn	ished by Woodville Line & Chemical Co.
Admixture	 Master Builders Po. MBVR ABA furnished 	しゃ しょうしょう しょうしゃ しいち 石 してきたい ひとうれんだけ 行法の知識 しながれた
DESIGNED MIXI		
Cement Admixture 1. Type 200-N Pozzolith 2. MBVR AEA Fine Aggregate Coarse Aggregate (1 1/2"-3/4") Coarse Aggregate (3/4"-#4) Coarse Aggregate - Total	588# 17.6 ounces 3.8 ounces * 1435# 620# 940# 1560#	588# 17.6 ounce# 4.0 ounces* 1440# 620# 940# 1.560#
Water, Net W/C Ratio Slump	36:5 gals 5:8 gal/sk 6" 6:25 sx/yd	>36.0 gals SSD
Cement Factor, Nominal Air Content Unit Weight of Plastic Concrete	5.5% 145.2 pcf	5.7% 144:8 pcf
COMPRESSIVE STRENGTH: (6" Diameter x 12	" High Cylinders)	
1 Day Strangth (psi) Cylinder #1 Cylinder #2 Average	1920 1960 1940	1960 2040 2000

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TWIN CITY TEST	ING AND	0 5 3 2 Ingineerin	IG LÅB	ORATOR	645-360 RY, INC.	
		Avenue - St. Paul, M			See 100	2
REPORT OF:		E MIX DESIGN				2
				DATE: Octob	er 22, 1970	
ABORATORY No. 6-7891			έ. • • •	PAGE: 2		
OMPRESSIVE STRENGTH: (6" 1	lameter x 12	"High Cylinders	s) (Continu	ed)		
Day Strength (psi) Cylinder #3		2600	* : * .	2770		
Cylinder #4 Average		2640 2620		2710 2740		
Dey Strength (psi)						
Cylinder #5 Cylinder #6		3450 3330		3470 3550	and the second second second	
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8 Day Strength (psi) Cylinder #7		4530		4890		
Cylinder #8		4650 4650 4590		4810 4850		
Average		4390		4800		の行

REMARKS :

he batch weights shown above are on the oven dry basis and should be adjusted for the amount of moisture in the aggregate at the time of batching.

The compressive strength specimens were cured in laboratory air in the molds for the first 48 hours. The ambient temperature was approximately 73° F and the relative humidity approximately 50%. The 28 day specimens were placed in the laboratory fog room at 2 days of age.

The amount of MBVR AEA will have to be varied to maintain the specified air content.

MUYUAL PROTECTION TO CLIENTS, THE PUBLIC AND CURSELVES, ALL REPORTS ARE SUBNITTED AS THE CONFIDENTIAL "ROPERTY OF CLIENTS. AND AUTH Ton Publication of statements, conclusions on extracts from on resarcing out meters is reserved pending our written approv

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Exhibit 12: NCR – Interim Field Report, W2C and Temp.

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Exhibit 12 BECHTEL 7749 SHEET 1 OF 1 INTERIM FIELD REPORT JOB NO. TECO & CEI PLANT Davis-Besse Nuclear Station UNIT 1. OWNER STARTUP SYSTEM: NO. N.A. NAME N.A. 1.2220) NON CONFORM, HOLD TAG NO. N.A. QC NO SUBJECT: Shield Building Slipform Concrete Mix Design C2-SF-4 Contract 7749-18 PROBLEM: Water cement ratio of mix design C2-SF-4 was exceeded for 48 cu.yds of concrete placed at el. 583'-6" in the containment shield building walls. Minimum temperature was below the specified requirement of 70 degress F. as per attached reports. Attachments: Concrete cylinder test reports for cylinder Nos. 170, 171, 172 and 175. S.U. TEST PROC. OPER. ERROR APPARENT CAUSE: ENGR'G CONSTR. REFERRED TO: ENGR'G_CONSTR. STARTUP SOLUTION OR SUGGESTED ACTION: The attached cylinder strength reports and mix plant inspection report indicate acceptable strengths were attained. Request Engineering approve this deviation from specification requirements on the basis of acceptable 28 day cylinder strengths. Code requirements in way of low temperatures for the placement area were not violated. Scg 0/9/73 H. W. Wahl 6/18/71 REPLY REQUESTED OF BY DATE (USE FIELD REPORT REPLY FORM) REPLY RECEIVED DATE 7, AUTHORIZATION TO PROCEED WITHOUT A WRITTEN REPLY DISTRIBUTION: VI - AC/PFE - FILE PREPARED BY SECH 2 - QAE Signed/Date 3 - ENGR'G **BECHTEL P&I DIVISION** Revised 6/70 **STARTUP FORM 47**

	BECHTEL 123200 1232000 1232000 123200 123200 1232000 1232000 1232000 1232000 1232000 12320000 12320000 123200000000000000000000000000000000000
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1997 - 1997 -	QC NO. <u>1.2220</u> NONCONFORM. HOLD TAG NO. <u>N.A.</u>
	SUBJECT: Shield Building Slipform Concrete Mix Design C-2-SF-4 Contract 7749-18 COMMENT: (SOLUTION OR CORRECTION ACTION TAKEN)
	Engineering has reviewed the Interim Field report and its attachments, relating to an excess of water in concrete mix C-2-SF-4.
	All concrete breaks are considerable higher than the 4000 psi specified No other harmful effects have been noted in the subject concrete. Consequently, Engineering approves the structure as it is constructed.
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	IMPORTANT: THE FOLLOWING ITEMS MUST BE FILLED OUT: FIELD CHANGE NOTICE REQUIRED YESNO_X FIELD CHANGE NOTICE ISSUED NUMBER AS BUILD DRAWING CHANGE REQUIRED YESNO_X
	DISTRIBUTION: 1 - QC/PFE 2 - QAE 3 - FILE BEC: NP PREPARED BY BECHTEL Signed/Date Joseph P. McGeady July 14, 1971
1	BECHTEL P&I DIVISION Revised 6/70 STARTUP FORM 48

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Exhibit 13: NCR – Interim Field Report (Wrong Mix)

ibit 13 BECHTEL INTERIM FIELD REPORT 7749 JOB NO. UNIT TECo - CEI PLANT Davis-Besse Power Station OWNER STARTUP SYSTEM: NO. N.A. NAME N.A. 1.2421) NON CONFORM, HOLD TAG NO. N.A. QC NO: Concrete placement Contract 7749-18 SUBJECT: Fegles Power Services, Inc., placed 6 yds. of C 1-3 PROBLEM: concrete in pour #2 at elevation 215'-6". Fly ash was not used in the batch. The batch plant operator apparently did not change the batch plant mix design punch card before producing the aforementioned concrete. APPARENT CAUSE: ENGR'G CONSTR. S.U. TEST PROC. OPER. ERROR REFERRED TO: ENGR'G CONSTR. STARTUP SOLUTION OR SUGGESTED ACTION: The Field recommends that Engineering approve this concrete as placed. The mix design is approved for use in Q-listed structures, the batch did not contain fly ash and is designed for the 4000 PSI strength requirements. The concrete batch ticket was checked and reveals acceptable quantities of all materials were used to produce the concrete in question. Drp4 6/9/73 BY DATE 6/18/71 REPLY REQUESTED OF H. W. Wahl (USE FIELD REPORT REPLY FORM) REPLY RECEIVED DATE AUTHORIZATION TO PROCEED WITHOUT A WRITTEN REPLY DISTRIBUTION: 1 - AC/PFE - FILE PREPARED BY BECHTEL 2 - QAE Signed/Date 3 - ENGR'G **BECHTEL P&I DIVISION** Revised 6/70 STARTUP FOR

3 Exhibit 13 REPORT NO. 2 FILE, NO. 0513, CC-5Q. BECHTEL INTERIM FIELD REPORT REPLY JOB NO, 7749 SHEET OF PLANT Davis-Besse Nuclear UNIT OWNER TECO-CEI Power Station NO. N. A. NAME N.A. STARTUP SYSTEM: -2220 QC NO. 1-24-21 NONCONFORM, HOLD TAG NO, N.A. SUBJECT: Concrete Placement Contract 7749-18- 6 yds OF C-1-3 concrete mix was placed in the shield building pour No. 2 @ elev. 215'-6". Fly ash was not used in the mix. (SOLUTION OR CORRECTION ACTION TAKEN) COMMENT: Pittsburg Testing Reports Nos. 275, 276, 277 & 278 on Concrete Cylinder Compressive Strength indicate that the concrete inadvertently placed in the shield building meets the specified minimum strength of . 4000 psi with considerable margin. No other concrete defects are discernible, Consequently, Engineering approves the concrete as it has been placed in the structure. No remedial action is required. IMPORTANT: THE FOLLOWING ITEMS MUST BE FILLED OUT: FIELD CHANGE NOTICE REQUIRED YES NO X FIELD CHANGE NOTICE ISSUED NUMBER AS BUILD DRAWING CHANGE REQUIRED YES NO X DISTRIBUTION: 1 - QC/PFE2 - QAE 3 - FILE PREPARED BY BECHT Signed/Date / seph i. McGe July 14, 1971 STARTUP FORM 48 BECHTEL P&I DIVISION Revised 6/70

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Exhibit 13

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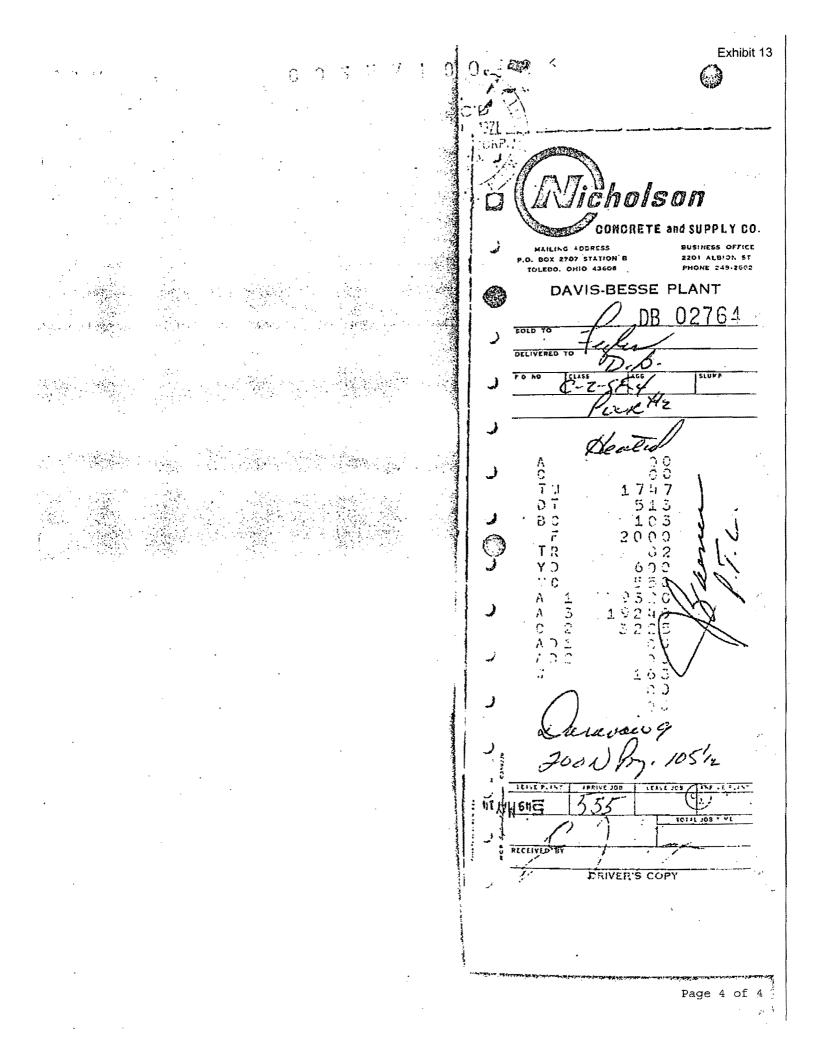
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х v² Exhibit 14: NCR 57 - Wrong Cement Type

PAG OF 8 NONCONFORMANC No. 57 REPORT SKET Yes X ATTACHED MO DAY Y DATE TTEM HELD REC AREA/BLOG 5 DWG/PART No. 8. ITEM NAME REV. 2 Containment Concrete Placement, Pour #2 -INSPECTION CRITERIA DOCUMENT NUMBER & TITLE OTHER [] (EXPLAIN) 7749-C-26 Form, Finish., Place. & Curing of Concrete DWG SPEC X MRI 1. ADDRESS 9. P.O. No. SOURCE: SUPPLIER , ENGRG CONSTR X STARTUP 1.2220 Fegles Power Service Minn., Minn. NONCONFORMANCE (DISCREPANCY) DESCRIPTION: No. ILIST SERIAL NUMBERS WHERE APPLICABLE) 1 PTL reports attached show that for 156 cu. yds .. Type II cement was used in place of * 1 Type I. Exhibits 1, 2 & 3 attached. A copy of Fegles Form No. 1, "Slip Form Daily Record," documents the occasion and the 1 8 reason. Exhibit 4 attached. • • PTL "Reports of Test on Concrete Cylinders" document the results of the test breaks on the cylinders involved, Exhibits 5 and 6 attached, See Exhibit 7 for location of pour. 4 31 • • 12. FIELD PRELIMINARY DISPOSITION: REWORK REJECT ROUTE TO PROJECT ENORG Both the 28-day test results and the 90-day test results far exceed spacification requirements indicating that the change in comput type did not adversely affect the required strength characteristics. Therefore, it is recommended that the concrete be accepted for use "as is", IS NCA PREPARED BY MUNARY DISPOSITION Zelan S. FINAL DISPOSITION: REPAIR ALIECT DCN No _ USE AS IS SEE BELOW NO 12 BECATEL ENGINETRING APPRILIES THE CONCRETE AS PLANED AND DESCRETE IN ITEM NO IL OF THIS NOR TO BE USED AS IS" BASID ON THE ACCEPT BASID ON THE ACCOMMENT 26 DAY COLLAGE COMPRESSION TESTS AS REPARTED APPROVAL OF EINSPECTION FINAL STID INS DISPOSITION MOP RASINAS ON TRACT NOT NOT

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Exhibit 15: Slip Form Time Quantities Analysis

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					Exhibit 5
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4/27/71	59-3"	41.3"	/32	2354	
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4/28/71	73'-6"				
4/2=/71	77:0				
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11	85'-5"				
	90:0"				
¥/30/71		4'-9"	** ** ***		
4/30/71		4'-11"			
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11	/			ан алаан а	
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5/5/71	139'-10*	4'-10#	222	5696	an operation and the second to the second second second second second second second second second second second
\$5/n	143'-6"	3'-8"	180	5876	
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4/	189'-5*				
1	193'-6"		/		
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5/12/11	202'-2"	4'-4"			
5/12/71	205 '-11"	3'-9"	ده میکند. مادیر کارمانی میکند. با میکند میکند میکند. میکند کار این میکند کار این میکند کار این میکند.	an story - emained allowing story of the courty is the growing story to a	
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11	214'-5"		B .		
13/	218'-3"				
11	223 -6"				

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PRTE		Pieck Ruchanna)	FASTALE JACULO	SHIFT CONCRETE	TOTAL CONTRACT	Extra 15
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5/1+/21		230"-9"	3"-11"	Jø d	9857	
5/14/21		234 - 2*	3'-5-4	181.5	10,038,50	
11		238'-8"			10.230.5	· · ·
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14/		296'-9"			10,578.5	
	1	250'-4"	· · · · · · · · · · · · · · · · · · ·		10,746,5	
13/11	2	253'-0'	an an a star and the star star star and the star star star star star star star star	namana aktu ba kalan da Kili da Kili da Kili da Kili kala kala kana ana sa kala sa sa sa sa sa sa sa sa sa sa s	10,854.5	
5/5/		258'-6'		••••••••••••••••••••••••••••••••••••••	10,962.5	39.1
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Exhibit 16: Rebar Cover Spacing (FENOC Document – Not Included as an Attachment to this Report)



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Exhibit 17: Spec C-29 Reinforcing Steel

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		Exh	nibit 17
	Power and foclustrial Division	Specification No. 7749-C-29 Job No. 7749 Q-List No. 1.2230 2	
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FILE COPY

BECHTEL COMPANY GAITHERSBURG, MARYLAND

No.	Date	Revisions		By	G.L./	C.E.	P/2.1	TECo	
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Power and Industrial Division

Specification No. 7749-C-29

SPECIFICATION REV. 2

INDIVIDUAL PAGE REVISION INDEX SHEET

Latest Individual Page No. Page Addendum No. 4 Cover Sheet Table of Contents 3 l 0 2 4 3 4 4 3 4

Documentation Distribution Requirements



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Power and Industrial Division

Specificatio o. 7749-C-29

TECHNICAL SPECIFICATIONS

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bewer and Industrial Division Specification No. 7749-C-29

TECHNICAL SPECIFICATIONS

FOR

FURNISHING, DETAILING, FABRICATING AND DELIVERING

REINFORCING STEEL

1.0 GENERAL

The WORK includes the formshing of all plant, labor, materials, tools and equipment and the performance of all operations and incidentals necessary to detail, furnish, fabricate, deliver, unload and store reinforcing steel and wire mesh fabric, as specified herein or as shown on the design drawings and in this Contract.

2.0 ABBREVIATIONS

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0 0 The abbreviations listed below, when used in these Specifications, shall have the following meanings and shall refer to the latest edition in effect on the date of the Contract.

ACI - American Concrete Institute ASTM - American Society for Testing and Materials AISI - American Iron and Steel Institute

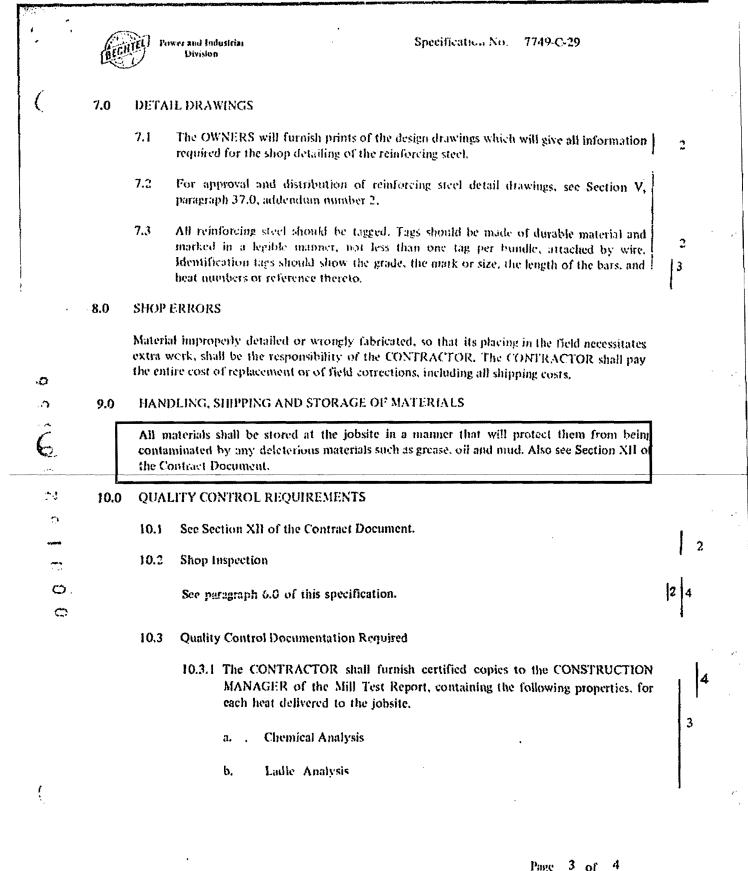
3.0 CODES AND STANDARDS

Except as otherwise specified or shown in the final design drawings, the detailing, fabrication, and tagging of all reinforcing steel shall be in accordance with the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" (ACI Standard 315).

4.0 MATERIAL

- 4.1 All material shall be new and unused free from loose rust, scale, or coatings which would reduce or destroy bond. Reinforcing appreciably reduced in cross section by bending shall not be used.
- 4.2 Reinforcing bars shall conform to the "Standard Specifications for Deformed Billet Steel Bars for Concrete Reinforcement" (ASTM A 615). Reinforcing bars shall be Grade 60 unless noted otherwise on the drawings.

	erci	卿 ,	bwer and Industrial Specification No. 7749-C-29 Division	
		4.3	Welded wire fabric for concrete reinforcement shall conform to "Specifications for Welded Steel Wire Fabric for Concrete Reinforcement" (ASTM A 185).	
	5.0	TES	TS	
		5.1	The CONTRACTOR shall furnish the required number of certified copies of all Mill [2] Test Reports to the respective parties bated on Form ED 6058 covering the chemical and physical properties of the reinforcing steel, as described in the referenced specifications and standards. Each delivery shall be identified by its applicable Mill Test Report.	
		5.2	The CONSTRUCTION MANAGER may, for the purpose of making chemical analysis checks and physical property tests, at his option, select random samples of the steel 12 delivered to perform user's tests as follows:	
			a. No. 11 bar size and samiler one random diameter size sample from each 50 tons of bar delivered for tension and bend tests.	
			b. No. 14 and No. 18 bar sizes one sample for each bar size from each 100 tons of bar delivered for tension test only.	3
		5.3	The OWNFRS' Independent Testing Laboratory will perform the user's tests and if the test sample bar does not meet the minimum strength requirements as defined in ASTM A 615, a second full-size sample from the same heat will be taken and tensile tested. If the latter test result meets the minimum strength requirements, results from these two tests will be combined with the mill tensile test result and averaged. If the averaged result is found to meet the minimum strength requirement, the heat will be accepted.	
с Ф			In the event that the averaged result of all three tests does not meet the minimum strength requirements, the heat will be rejected.	
0		5.4	The method of testing will conform to the AST'M A 615 requirements.	
		5.5	The CONTRACTOR shall furnish sufficient bars with each shipment to satisfy the testing needs of Paragraph 5.2.	
	6.0	INSF	PECTION	I
		eeivii adeq	WORK shall include receiving inspection at the jobsite by the CONTRACTOR. The re- ng inspection shall determine that the requirements of ASTM-A615 have been met, that uate documentation as required by paragraph 10.3.4 accompany the delivery, and that ng conforms to paragraph 7.3 and the shop detail drawings.	4
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			Page 2 of 4	



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Specification No. 7749-C-29

Power and Industrial

are an Scarae ĩ .se \mathcal{O} \odot

- ¢, Tension Test
- d. Bending Test (except No. 14 and No. 18 bars)
- **Elongation Test** ę.

MEASUREMENT AND PAYMENT 11.0

Division

- 11.1 The Lump Sum Price for the complete WORK for the Shield Building shall include the reinforcing steel specified herein. The unit prices bid in Paragraph 2.2 and 2.3 of the Proposal shall be used for additions to or deletions from the Lump Sum bid in Items 2.1.1 and 2.1.2, respectively, of the Proposal. Only net changes in quantities as directed by the CONSTRUCTION MANAGER or the ENGINEER shall constitute additions to or deletions from the Lump Sum bids.
- Net changes in quantities shall be calculated on the theoretical lengths of the bars as 11.2 detailed, and at the theoretical weights as given in the "Standard Specifications for Deformed Billet Steel Bars for Concrete Reinforcement" (ASTM A 615).

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Exhibit 18: Wall Plumb Measurements

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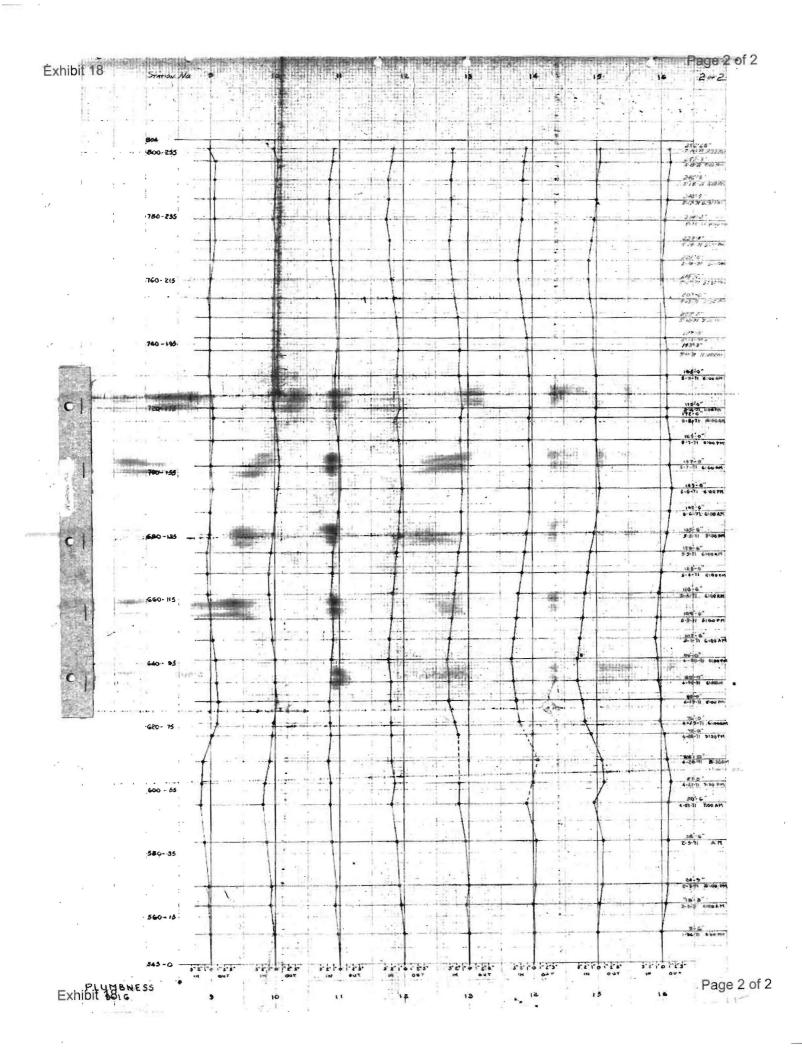




Exhibit 19: Out-of-Plumb Interim Field Reports

0	OWNER TECS-CEI PLANTDavis-Besse Nuclear Power StationVNIT 1 STARTUP SYSTEM: NO. NA NAME Containment Sheild Building
	QC NO. 1,2220 NON CONFORM, HOLD TAG NO. NA
	SUBJECT: Containment shield building out of plumbness, Contract 2749-18
	PROBLEM: The Containment Shield building concrete wall outside face is not within the plumbness tolerance of 1 inch in any 25 feet; She attached charts plotting plumbness; readings.
Ō	
	APPARENT CAUSE: ENGR'G CONSTR. S. U. TEST PROC. OPER. ERROR REFERRED TO: ENGR'G CONSTR. STARTUP
	SOLUTION OR SUGGESTED ACTION: Evaluate existing structure and approve as placed or provide recommended action.
	REPLY REQUESTED OF U.W. Vahl BY DATE 6/28/21 (USE FIELD REPORT REPLY FORM) REPLY RECEIVED DATE AUTHORIZATION TO PROCEED WITHOUT A WRITTEN REPLY
14 10 10 10 14 14 14 14 14 14 14 14 14 14 14 14 14	DISTRIBUTIONI 1 - AC/ PPE - FILE 2 - QAE 3 - ENGR'G

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OW ST	NER <u>TECo - CEI</u> ARTUP SYSTEM: NO. <u>N.</u>	TERIM FIELD REPORT REPLY REPORT NO. 5 PLANT <u>Davis-Besse Nucle</u> Power Station A. NAME <u>Containment Shiel</u> ONFORM. HOLD TAG NO.	d Building					
	UBJECT: Containment	Shield Building out of plumb 249-18						
C	<u>。这些人,这些</u> 有些意义是希望	<u> April Andreas (1977) - Englished (1977)</u>						
	COMMENT: (SOLUTION OR CORRECTION ACTION TAKEN) Engineering has reviewed the Interim Field Report and its attached plumbness plots. Out of colerance exceeds the 1" in 25' specified by 2-3/4". The effects this has on the shield building structural integrity were found to be insignificant.							
	Bugineering recommends that all interface work be adjusted to meet the as-built alignment of the structure.							
	The structure is accepted as is.							
	FIELD CH	G ITENS MUST BE FILLED OUT: ANGE NOTICE REQUIRED ANGE NOTICE ISSUED DRAWING CHANGE REQUIRED	YES_NO_X_ NUMBER_NAAL YES_X_NO					
Sec. Astron	TRIBUTION: -/QC/PPB - QAE - FILE	PREPARED BY	BEITERL					



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Exhibit 20: Slip-Form Records Summary

Davis-Besse Containment Shield Building Records

Davis-Besse Containment Shield Building Construction

Data taken from slip form record

Date	Shift	Outside Temp	Deck Elevation	Footage jacked	Shift Concrete	Total Concrete	Comments
01/25/71	1	31	4'0"	0	108	108	1 6 cy batch rejected 81/4 slump
01/25/71	2	37	5'8"	1'8"	132	240	
01/26/71	3	38	8'8'	3'0"	108	348	1 6 cy batch rejected 7 slump
01/26/71	1	29	10'8"	2'0"	42	390	Pour stopped at 10 am due to high winds
02/01/71	1	5	?				
02/01/71	2	9	14'10'	3'0'			Weather cold
02/01/71	3	0	17'8'	2'10'	108		
02/02/71	1	-2	19'8"	2'8"	108	86?	
02/02/71	2	12		2'10"	102	968	6 cu yd dumped on 2 nd shift because to tower crane down time
02/02/71	3	16	24'9"	3'0"	114	1092	
02/03/71	1	19	28'8"	3'11"	162		
02/03/71	2	22	31'11"	3'8"	132		
02/03/71	3	21	34'2"	2'8"	90		
02/04/71	1		37'6"	3'4"	192		
02/04/71	2	32	38'6"	1'0"	66		Pour stopped at 583'6" at el. Waterstop inserted and key way poured
				ER BARREL			Pour apparently stopped. Maybe due to cold weather!
04/26/71	1		43'4"	3'9"	150	1314	Date?
04/26/71	2		47'5"	4'1"	144	1458	
04/26/71	3		51'0"	3'7"	126	2084	The concrete below the moving forms after being finished was sprayed with clean seal #12 by Drace Co.
04/27/71	1		55'0"	4'0"	138	2222	Engineering on 12 hour shifts The concrete below moving form cured with Brace's clear seal #12
04/27/71	2			4'3'	170	2504	
04/29/71	1		68'7"	5'1"	168	2672	
04/29/71	2		73'6'"	4'11"	156	2822	
04/29/71	3	-	77'0"	5'6"	144	2972	Concrete below moving form cured with Graces's clear seal #12
04/30/71	1		94'4"	4'9"	210	3710	
04/30/71	2		99'8"	4'11"	198	3906	

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Davis-Besse Containment Shield Building Records

05/01/71	3	103'11"	5'5"	156	4064	Construction joint water cured and water cut before starting next pour. Concrete below moving form cured with Graces's Clear Seal #12
05/03/71	1	108'6"	5'5"	216	4280	
05/03/71	2	113'2"	4'8"	192	4472	
05/04/71	3	117'6"	4'4"	192	4464	4 story poles checked on 5-1-71 by taping up from B.M. el 549'0" on inside wall pole near yoke #1 1/16" short -pole near yoke #21: 1/16" short; -pole near yoke #41: 3/16" short - pole near yoke #61: 1/16" short
05/04/71	1	122'6"	4'6"	198	4862	
05/04/71	2	126'6"	4'6"	204	5066	
05/05/71	3	130'3"	3'9"	180	5246	Concrete below moving form cured with Grace's clear seal #12
05/06/71	1	140	4'11"	216	6092	•
05/06/71	2	153'3"	4'10"	234	6314	
05/07/71	3	158'4"	5'1"	207	65??	Concrete below moving from cured with Grace's clear seal #12
05/07/71	1	163'4"	5'0"	234	6776	
05/07/71	2	167'10'`	4'6"	204	6980	
05/08/71	3	171'10"	4'0"	204	7184	Concrete below moving form cured with Grace's clear seal #12 Construction joint water cured and water cut before starting the next pour
05/10/71	1	176'9"	4'11"	215	74??	
05/10/71	2	183'3"	4'6"	198	7598	
05/11/71	3	185'10'	4'7"	204	7802	4 story poles checked on 5-8-71 by taping up from B.M. el. 549'0" on inside wall: Story pole near yoke #1 0'01/8"short Story pole near yoke #21 0'01/8" short Story pole near yoke #41 0' 01/4" short Story pole near yoke #61 0" ¼" short
05/11/71	1	189'5"	3'7"	180	7982	
05/11/71	2	193'4"	4'4"	184	8162	
05/12/71	3	197'10"	4'4"	210	8372	6 cy of concrete was sent back to the batch plant due to time factor (governed by the spec) due to a break down in the tower crane. Concrete below moving form cured with Grace's clearseal #12
05/12/71	1		4'4"	192	8564	
05/12/71	2	205'11"	3'9'	174	8738	

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Davis-Besse Containment Shield Building Records

05/13/71	3	210'4"	4'5"	198	8932	Concrete below moving form cured with Graces Clear seal #12
05/13/71	1	214'5"	4'1"	180	9116	
05/13/71	2	218'3"	3'10"	174	9290	
05/14/71	3	222'6"	4'3"	192	9482	Concrete below moving form cured with clear seal #12
05/14/71	1	226'10"	4'4"	195	9677	
05/14/77	2	230'9"	3'11"	180	9857	
05/15/71	3	234'2"	3'5"	181.5	10038.5	4 Story poles checked on 5-15-71 by taping up B.M. el. 549'0" on inside wall; Story pole near yoke #1 – 0' 0 1/8" short Story pole near yoke #21 – 0' 03/16" short Story pole near yoke #41 – 0' 0 3/16" short Story pole near yoke #61 – 0' 05/16" short On 5/14/71 2 nd shift truck #82 ticket DB02764 delivered 02764 delivered 6 cuyds of concrete with Type II cement instead of Type I cement. Concrete below moving form cured with Braces Clear Seal #12.
05/17/71	1	238'8"	4'6"	192	10230.5	
05/17/71	2	242'6"	3'10"	156	10, 386.5	
05/18/71	3	246'9"	4'3"	192	10578.5	Concrete below moving form cured with Graces Clear Seal #12
05/18/71	1	250'4"	3'7"	168	10726.6	
05/18/71	2	253'0"	2'8"	108	10854.5	
05/18/71	3	256' 61/2"	3'6 ½"	108	10962.5	On 5-18-71. about 9:30 pm the concrete mix was noted as being sticky and not as consistent a mix as it should be. The slump was 3". The problem appeared to be the cement – to try to correct the problem the mix was changed to type II cement at about 11:30 pm 5-18-71. Concrete cured with Graces Clearseal #12 before moving form.
05/19/71	1	256' 61/2"	0,0"	66	11028.5	Concrete struck off @ 256'0 ½" & 256'6 ½" water stop and keyway in place and water is being piped to the top of the shield wall for curing the concrete for required time. Concrete below moving form cured with Graces Clearseal #12



Exhibit 21: Guide for Preparation



Guide for the Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods

Guideline No. 03737

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International Concrete Repair Institute 3166 S. River Road, Suite 132, Des Plaines, IL 60018 Phone: 847-827-0830 Fax: 847-827-0832 Web: www.icri.org E-mail: info@icri.org

About ICRI Guidelines

The International Concrete Repair Institute (ICRI) was founded to improve the durability of concrete repair and enhance its value for structure owners. The identification, development, and promotion of the most promising methods and materials is a primary vehicle for accelerating advances in repair technology. Working through a variety of forums, ICRI members have the opportunity to address these issues and to directly contribute to improving the practice of concrete repair.

A principal component of this effort is to make carefully selected information on important repair subjects readily accessible to decision makers. During the past several decades, much has been reported in

Technical Activities Committee

Rick Edelson, Chair David Akers Paul Carter Bruce Collins William "Bud" Earley Garth Fallis Tim Gillespie Fred Goodwin Scott Greenhaus Robert Johnson Kevin Michols Allen Roth Joe Solomon

Synopsis e is intended

This guideline is intended to provide an introduction to hydrodemolition for concrete removal and surface preparation, the benefits and limitations of using hydrodemolition, and an understanding of other aspects to be addressed when incorporating hydrodemolition into a repair project. This guideline provides a description of the equipment, applications, safety procedures, and methods of water control and cleanup. literature on concrete repair methods and materials as they have been developed and refined. Nevertheless, it has been difficult to find critically reviewed information on the state of the art condensed into easy-to-use formats.

To that end, ICRI guidelines are prepared by sanctioned task groups and approved by the ICRI Technical Activities Committee. Each guideline is designed to address a specific area of practice recognized as essential to the achievement of durable repairs. All ICRI guideline documents are subject to continual review by the membership and may be revised as approved by the Technical Activities Committee.

Producers of this Guideline Subcommittee Members

Pat Winkler, Chair Don Caple Bruce Collins Eric Edelson Ken Lozen Bob Nittinger Steve Toms

Contributors

Scott Greenhaus Rick Toman Mike Woodward

Keywords

Bond, bonding surface, bruising, chipping hammer, coating, concrete, delamination, deterioration, full depth repair, hand lance, high-pressure water, hydrodemolition, impact removal, mechanical removal, micro-fracture, post-tensioning, rebar, reinforced concrete, reinforcing steel, robot, rotomill, safety, sound concrete, surface preparation, surface profile, surface repair, tendon, vibration, wastewater, and water jet.

This document is intended as a voluntary guideline for the owner, design professional, and concrete repair contractor. It is not intended to relieve the professional engineer or designer of any responsibility for the specification of concrete repair methods, materials, or practices. While we believe the information contained herein represents the proper means to achieve quality results, the International Concrete Repair Institute must disclaim any liability or responsibility to those who may choose to rely on all or any part of this guideline.

Purpose

This guideline is intended to provide owners, design professionals, contractors, and other interested parties with a detailed description of the hydrodemolition process; a list of the benefits and limitations of using hydrodemolition for concrete removal and surface preparation; and an understanding of other aspects to be addressed when incorporating hydrodemolition into a repair project. The guideline provides a description of the equipment, applications, safety procedures, and methods of water control and cleanup. This guideline is not intended as an operating manual for hydrodemolition equipment as that information is specific to each equipment manufacturer.

The scope of this guideline includes the use of hydrodemolition for the removal of deteriorated and sound concrete in preparation for a concrete surface repair. In addition, the use of hydrodemolition for the removal of coatings is discussed.

While the procedures outlined herein have been found to work on many projects, the requirements for each project will vary due to many different factors. Each project should be evaluated individually to ascertain the applicability and cost-effectiveness of the procedures described herein. Other methods of surface preparation are discussed in ICRI Technical Guideline No. 03732, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays."

Introduction

Hydrodemolition is a concrete removal technique which utilizes high-pressure water to remove deteriorated and sound concrete. This process provides an excellent bonding surface for repair material. First developed in Europe in the 1970s, this technology has become widely accepted for concrete removal and surface preparation throughout Europe and North America.

Hydrodemolition can be used for horizontal, vertical, and overhead concrete removals and surface preparation on reinforced and nonreinforced structures. It is effective in removing concrete from around embedded metal elements such as reinforcing steel, expansion joints, anchorages, conduits, shear connectors, and shear studs. Hydrodemolition can be used for localized removals where deterioration is confined to small areas and for large area removals in preparation for a bonded overlay. This technology can also be used to remove existing coatings from concrete. Hydrodemolition has been used on the following types of structures:

- · Bridge decks and substructures
- Parking structures
- · Dams and spillways
- Water treatment facilities
- · Tunnels and aqueducts
- Nuclear power plants
- Piers and docks
- Stadiums
- Warehouses
- Retaining walls

The Effects of Mechanical Impact Techniques

Mechanical methods such as chipping hammers, rotomills, scabblers, and scarifiers remove concrete by impacting the surface. These procedures crush (bruise) the surface, fracture and split the coarse aggregate, and create micro-fractures in the substrate (Fig. 1 and 2). As a result, the ability of the fractured substrate to provide a durable

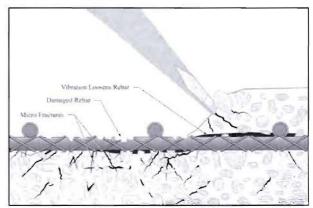


Fig. 1: Damage created by chipping hammer

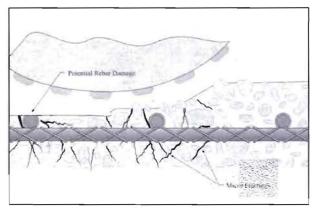


Fig. 2: Damage created by rotomilling

bond with the repair material is compromised, requiring a second step of surface preparation to remove the damaged region.

Furthermore, impact methods may damage the reinforcing steel and embedded items such as conduit, shear studs and connectors, and expansion joint hardware. Impact methods transmit vibrations through the reinforcing steel, which may cause further cracking, delamination, and loss of bond between the reinforcing steel and the existing concrete. Vibration and noise created by the mechanical impact will travel through the structure,

disturbing the occupants. During repair of thin slabs and precast tees, chipping hammers may shatter the substrate resulting in unanticipated full depth repairs.

For a discussion on surface bruising and the mechanics of concrete removal by impact methods, refer to ICRI Technical Guideline No. 03732, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings and Polymer Overlays."

Hydrodemolition Benefits and Limitations

The benefits of hydrodemolition can be placed into two groups: structural benefits that improve the quality of the repair, and environmental benefits that improve the quality of the work place. Hydrodemolition also has limitations, which need to be considered.

Structural Benefits

- A rough, irregular surface profile is created to provide an excellent mechanical bond for repair materials;
- Surface micro-fracturing (bruising) is eliminated;
- Exposed aggregates are not fractured or split;
- Lower strength and deteriorated concrete is
- selectively removed;
- Vibration is minimal;
- Reinforcement is cleaned, eliminating the need for a second step of surface preparation; and
- Reinforcing and other embedded metal elements are undamaged.
- During concrete removal, the water jet is directed
- at the surface, causing high-speed erosion of the cement, sand, and aggregate. The water jet does
- not cut normal weight aggregate which remains
- intact and embedded as part of the rough, irregular
 - surface profile (Fig. 3). The aggregate interlocks
 - with the repair material to assist in developing a



Fig. 3: Surface prepared by hydrodemolition has a rough irregular profile with protruding aggregate and is excellent for creating a mechanical bond

mechanical bond and composite action between the substrate and the repair material.

The rough, irregular surface profile provided by hydrodemolition can result in bond strengths that equal or exceed the tensile strength of the existing concrete. The concrete surface profile can exceed CSP-9 (very rough) as defined in ICRI Technical Guideline No. 03732.

Rotomills and scarifiers remove concrete to a uniform depth and may leave deteriorated concrete below the specified depth. Alternatively, the water jet moves in a consistent pattern over the surface and will remove unsound concrete even if it is below the specified depth.

Since the water jet does not create mechanical impact, vibration is not transmitted into the structure from the hydrodemolition operation. Delamination beyond the repair area caused by vibration of the reinforcing steel is greatly reduced.

During hydrodemolition, sand and cement particles mix with the water jet. The abrasive action of theses particles is usually sufficient to clean uncoated reinforcing bar and embedded metal items without damaging them. Corrosion material is removed from the reinforcing bar and metal items, allowing for easy inspection and identification of cross-sectional area loss. The reinforcing bar is cleaned without any loss of deformations. Cleaning of the entire reinforcing bar, however, will not occur if the reinforcing bar has not been completely exposed during hydrodemolition.

Environmental Benefits

- Minimizes disruptions to users of occupied space by significantly reducing transmitted sound through the structure;
- Increased speed of concrete removal can reduce construction time;
 - Minimizes dust; and

• Robotic units reduce labor and minimize injuries as compared to chipping hammers.

Concrete removal by hydrodemolition can take place inside an occupied structure, such as a hotel, apartment building, office building or hospital with minimal noise disruption to the occupants.

Hydrodemolition can quickly remove concrete. As such, project duration can be reduced, minimizing the impact on the users of the structure.

During demolition, cleanup, and final wash down, the concrete debris and repair surface remain wet, minimizing dust in the work area. Since hydrodemolition cleans the reinforcing steel, the need to sandblast is eliminated unless additional concrete removal is required using chipping hammers. As such, silica dust in the work area is reduced, thereby providing a safer work environment.

The use of chipping hammers and other impact methods are labor intensive and physically demanding, which can cause injury to the employee. Robotic hydrodemolition equipment reduces the use of these tools and the possibility of injury.

Limitations

- The hydrodemolition process consumes a significant amount of water (6 to 100 gpm [25 to 380 lpm]). A potable water source must be available. The cost of the water should be considered;
- Wastewater containing sand and cement fines (slurry) must be collected, treated, and returned to the environment. Wastewater disposal may require a permit;
- Projects requiring total demolition can be done faster and more economically with crushers and similar equipment;
- Water can leak through cracks in the concrete and damage occupied space below the repair area. Hydrodemolition should not be used over occupied areas due to the risk of blow-through (unanticipated full-depth removal);
- Repair areas of varying strength will result in non-uniform removal. Areas of high strength may need to be removed using hand lances or chipping hammers;
- The water jet is blocked by reinforcing steel resulting in concrete shadows under the reinforcing bar that may need to be removed using hand lances or chipping hammers;
- Since the water jet of a robotic unit is contained in a metal shroud, some robots are unable to completely remove concrete up to a vertical surface such as a curb, wall or column. The remaining concrete may have to be removed using hand lances or chipping hammers;

- The water jet will remove the sheathing from post-tensioning tendons and may drive water into the tendon;
- The hydrodemolition robot may be too large to access small or confined areas of the structure;
- The water jet can damage coatings on reinforcing steel and other embedded items;
- The water jet can introduce water into electrical system components, especially if embedded in the concrete and already deteriorated or not properly sealed; and
- If cleanup is not properly performed in a timely manner, further surface preparation may be required.

The Hydrodemolition System

The hydrodemolition system consists of a support trailer or vehicle, high-pressure pump(s), a robotic unit to perform the demolition, and high-pressure hoses to connect the pump(s) to the robot. Hand lances are also available to remove concrete in areas inaccessible to the robot.

Support Trailer

Hydrodemolition units are typically transported on 40 to 50 ft trailers (Fig. 4). The robot may

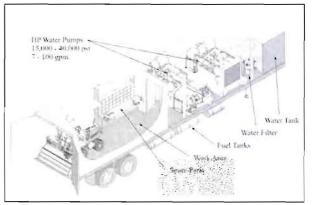


Fig. 4: Hydrodemolition support trailer. A selfcontained unit transports pumps, robot, hoses, and spare parts

be transported on the same trailer or separately on a smaller trailer. The support trailer usually contains a supply of spare parts, tools, maintenance area, fuel and water storage, supply water hoses, and filters. These units are designed to be self-sufficient on the job site with adequate spare parts to perform routine maintenance and repairs.

High Pressure Pumps

The high-pressure pumps used for hydrodemolition are capable of generating pressures from 10,000 psi to 40,000 psi (70 to 275 MPa) with flow rates from 6 to 100 gpm (25 to 380 lpm). The pumps are driven by a diesel or electric motor, typically operating between 100 and 700 horsepower. The engine size will vary based on the flow and pressure rating of the pump. The pumps operate most efficiently at their design pressure and flow. High-pressure hoses connect the pumps to the robot. The pumps may be located a significant distance (500 ft [150 m]) from the actual removal area. However, due to a drop in pressure and flow through the highpressure hoses, the pumps should be located as close as possible to the removal area, typically within 300 ft (100 m).

Robotic Removal Unit– Horizontal Surfaces

The force created by the high-pressure pump(s) is controlled using a robotic removal unit (Fig. 5). The robot is a diesel or electric powered, self-propelled, wheeled or tracked vehicle. It is used to uniformly move and advance the water jet over the surface during concrete removal.

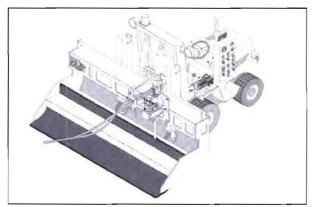


Fig. 5: Typical hydrodemolition robot

The water jet is mounted on a trolley that traverses over the removal area along a cross feed or traverse beam (Fig. 6) perpendicular to the advance of the robot. The water-jet nozzle may either oscillate or rotate (Fig. 7). The oscillating nozzle is angled forward in the direction of the traverse. Rotating nozzles are angled from the center, creating a cone effect while rotating (Fig. 8 and 9).

The nozzle assembly is enclosed within a steel shroud with rubber seals around the perimeter to contain the debris during demolition (Fig. 10).

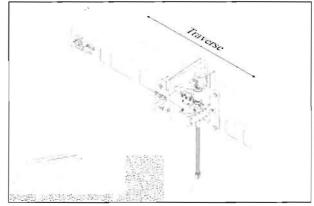


Fig. 6: Nozzle is mounted on a traverse beam

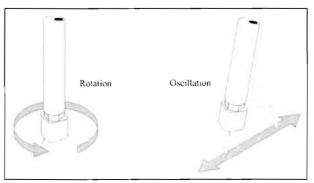


Fig. 7: Rotating or oscillating nozzles

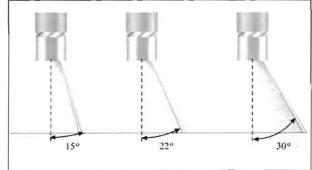


Fig. 8: Rotating nozzles are angled from center

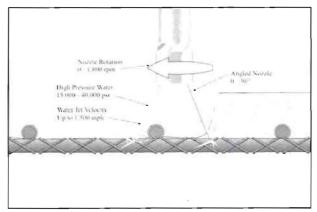


Fig. 9: Rotation of the angled nozzle creates a water cone

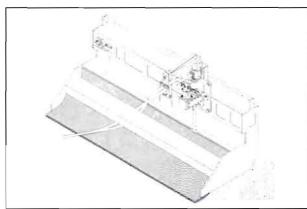


Fig. 10: Nozzle is enclosed within a steel shroud

The rotation/oscillation of the nozzle combined with the traverse and advance of the robot provide a uniform and continuous motion of the water jet over the removal area (Fig. 11). Each of these functions is fully adjustable. The depth of concrete removal is determined by the length of time the water jet is directed at the removal area.

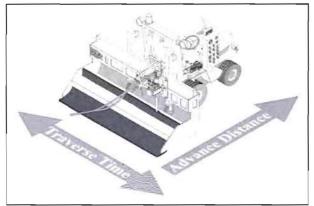


Fig. 11: The water jet traverses back and forth perpendicular to the forward advance of the robot

Adjusting the following parameters will increase or decrease the depth of removal:

- a. Total traverse time (time of each traverse × number of traverses); and
- b. Distance of the advance.

Once these parameters are set, the robot will reproduce the settings in a programmed sequence to provide consistent removal of the concrete. For example, during deep removal to expose the reinforcing bar 3 to 4 in. (75 to 100 mm), the traverse speed may be 8 seconds (the time required for the water jet to move from one side of the traverse beam to the other) and the water jet may traverse 3 times before the robot advances forward 1 to 2 in. (25 to 50 mm). On the other hand, for light scarification 1/4 to 1/2 in. (6 to 13 mm) or coating removal, the traverse speed may be 3 seconds and the water jet may traverse only one time before the robot advances 2 to 4 in. (50 to 100 mm).

The depth of concrete removal is controlled at the robot. Since the pumps are designed to operate at a specific pressure and flow rate, it is unusual to reduce the pressure (and subsequently the flow rate) to adjust the depth of removal.

Narrow areas may be removed by adjusting sensors that limit the movement of the water jet along the traverse beam. The traverse and advance functions limit the removal to a rectangular area along the advance path of the robot. Because the water jet is contained within a steel shroud, most robots are unable to remove concrete within 3 to 6 in. (75 to 150 mm) of vertical surfaces.

Specialized Robotic Equipment— Vertical and Overhead Surfaces

Various types of robotic equipment are available to perform removals on walls, soffits, substructures, beams, columns, and tunnels. These robots are often built on wheeled or tracked vehicles and have the ability to lift the traverse beam into the vertical or overhead position. The primary functions of traverse and advance are utilized in order to provide uniform concrete removal during vertical and overhead repairs.

As an alternative to the robot, the water jet may also be attached to a frame that allows the jet to move in a two dimensional "X-Y" plane. The X-Y movement of traverse and advance are present in these units to provide uniform concrete removal. The X-Y frames can be lifted and positioned over the removal area using a crane, backhoe, allterrain forklift or other similar equipment.

Hand Lance

Hand lances operate at pressures of 10,000 to 40,000 psi (70 to 275 MPa) while delivering approximately 2 to 12 gpm (8 to 45 lpm) of water. Hand lances are not as fast or as precise for concrete removal as a programmed robot and are slower than chipping hammers. Hand lances are effective in performing light scarification and coating removals. It should be noted that the water jets on hand lances may not be shrouded, increasing the risk of debris becoming airborne. Hand lances can be used for removal of:

- · Concrete shadows below reinforcing bar;
- Concrete adjacent to walls, columns, curbs, and in tight and confined areas not accessible to the robotic equipment; and
- Coatings.

Safety

Hydrodemolition involves the use of potentially dangerous specialized equipment. At all times, the manufacturer's instructions for the safe operation of the equipment and personal protective equipment should be followed, as well as all local, state, and federal regulations. Hydrodemolition units should be supervised and operated by qualified personnel certified by the equipment manufacturer.

Hydrodemolition employs high-velocity water jets to demolish concrete and perform surface preparation. Even though the water jet is shrouded on robotic units, debris can be propelled from beneath the shroud with sufficient velocity to cause serious injury. Serious injury or death can also occur if struck by the water jet. Hand lances are typically not shrouded and care must be exercised to avoid injury when using these tools.

Workers, equipment operators, and any individuals entering the work area are required to wear hard hats, safcty glasses, hearing protection, safety shoes, gloves, long pants and long-sleeve shirts, and must be trained in the proper use of personal protective equipment. When using a hand lance, the operator should wear a full-face shield, rain suit, and metatarsal and shin guards. Additional protective clothing may also be required for use with hand lances. Everyone involved with the hydrodemolition operation should receive specific training outlining the dangers associated with the use of high-pressure water.

Prior to starting demolition, an inspection of the area should be performed including the area under the work area. All barricades, partitions, shielding, and shoring must be installed and warning signs posted to prevent unauthorized entry into the work area. The area below the work area must be closed off and clearly marked "Danger-Do Not Enter." Electrical conduits or other electrical equipment in the work area should be deenergized to avoid electrical shock.

Special precautions are required for posttensioned structures as referred to in the section "Considerations for Hydrodemolition Use."

Hydrodemolition Applications

Scarification

Scarification is performed to remove the surface concrete and provide a rough profile (Fig. 12 and 13). Scarification is often used in preparation for



Fig. 12: Scarified surface with 1 in. aggregate



Fig. 13: Scarified surface with 3/4 in. aggregate

a concrete overlay. If the surface was previously rotomilled, the minimum removal depth using hydrodemolition should equal the size of the coarse aggregate to remove all concrete micro fractures and damaged or crushed aggregate.

Scarification may not remove all unsound concrete due to the rapid rate at which the water jet moves over the surface. It may be necessary to resurvey the scarified surface and identify delaminated or deteriorated areas for further removal.

Partial Depth Removal

Partial depth removal is commonly required if chloride contamination has reached the top mat of reinforcing steel or deterioration, delamination or spalling occurs within the top mat of reinforcing steel. Partial depth concrete removal can expose the top mat of reinforcing steel and provide clearance, typically a minimum of 3/4 in. (19 mm), below the bottom reinforcing bar of the top mat (Fig. 14 and 15). Determining the reinforcing bar size and concrete cover are critical to determine the required removal depth.

Concrete removal using hand lances or chipping hammers may be required to remove shadows under the reinforcing bar, previously repaired areas

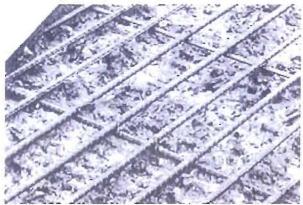


Fig. 14: Partial depth removal



Fig. 15: Partial depth removal on a retaining wall

or high areas resulting from variations in the strength of the concrete. In addition, concrete removal may be necessary adjacent to vertical surfaces such as curbs, walls and columns. Saw cutting of the perimeter of the repair area, if required, should be performed after hydrodemolition to prevent damage to the saw cut. This will require additional concrete removal along the repair perimeter with hand lances or chipping hammers. If the saw cut is made first, the area outside the saw cut should be protected using a steel plate. The steel plate will allow the water jet to slightly over run the saw cut without damaging the surface outside the saw cut while completely removing the concrete within the repair area.

Full Depth Removal

Hydrodemolition can be used for full depth removal where delamination has occurred in the lower mat of reinforcing or chloride contamination exists throughout the entire thickness of the slab. Full depth removal can be performed along expansion joints and other areas where there is a high concentration of reinforcing steel that may be damaged if conventional removal methods are used. Other structural elements such as shear connectors, shear studs, and steel beam flanges can be exposed without damage.

During full depth removal, the removal rate slows as the depth increases because the water jet stream dissipates as it moves away from the nozzle and the water jet must push more water and debris from its path prior to contacting the surface to be removed.

Full depth removal is often necessary on waffle or pan joist slab systems (Fig. 16).



Fig. 16: Full depth removal-waffle slab

Coating Removal

Hydrodemolition can be used for the removal of epoxy, urethane, hot applied membrane, and other coatings from concrete surfaces (Fig. 17). When performing coating removal, a multiple jet nozzle is used. The multiple jets allow the water to penetrate the coating without damaging the concrete. However, if the concrete below the coating is deteriorated, it may be removed along with the coating.



Fig. 17: Coating removal using a spinning, multi-nozzle pra head

The Hydrodemolition Process

Concrete removal by hydrodemolition is impacted by the following factors:

- Size and density of the aggregate;
- · Concrete strength;
- Uniformity of concrete strength;
- · Extent of cracking;
- · Deterioration and delamination;
- Surface hardeners;
- Previous repairs with dissimilar strength material; and
- Size and spacing of reinforcing steel or other embedded items.

In sound concrete, the variation in the depth of removal will generally equal the size of the coarse aggregate (Fig. 18). For example, if the coarse aggregate is 1 in. (25 mm), D = 1 in. (25 mm) and the specified depth of removal is 2 in. (50 mm), the range of removal will be 2 in. (50mm) $\pm D/2$ (1/2 in. or 13 mm), or 1-1/2 in. (38 mm) to 2-1/2 in. (63 mm).

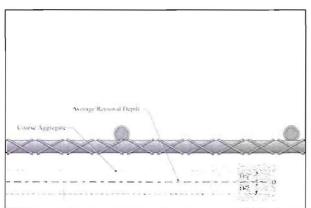


Fig. 18: The depth of removal depends on the size of the course aggregate

During hydrodemolition, a high-pressure water jet is uniformly moved over the surface and, provided the concrete is sound and the strength does not change significantly, the removal depth will remain consistent. Depth variations occur when the concrete strength changes, cracking or delamination is present, the concrete is deteriorated or the surface has been previously repaired using a different type and strength of material. In comparison, rotomilling or dry-milling equipment can be set to a specific depth and the milling drum will mill the surface to that depth regardless of any variations in the concrete strength, quality or level of deterioration. If the strength of the concrete increases or a high-strength repair area is encountered during hydrodemolition, the removal depth will decrease (Fig. 19). The decrease in depth may not be immediately detected by the operator, resulting in an area of shallow removal (Fig. 20). To obtain the required depth in higher strength concrete, the total traverse time is increased and the advance of the robot is decreased. If the highstrength repair area is large enough, it may be possible to set up the hydrodemolition robot over the area and remove to the specified depth. This

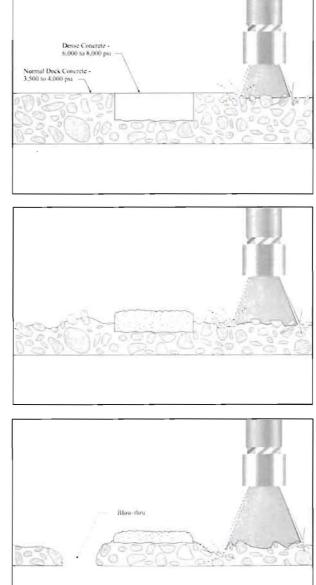


Fig. 19: High-strength concrete is removed at a slower rate than normal concrete, which can result in a nonuniform removal



Fig. 20: High-strength repair area within the hydrodemolition area

procedure can be problematic for two reasons. First, if the water jet overruns the high-strength repair area, it may result in a blow-through or full depth removal at the perimeter of the high-strength repair area. Second, since the water jet must be slowed significantly, it may cause excessive removal below the high-strength area once it is removed and the softer base concrete is exposed. For these reasons, it is often preferable to use chipping hammers in high-strength repair areas.

The opposite effect is encountered if the concrete strength decreases or there is cracking, deterioration or delaminations (Fig. 21). Concrete that is deteriorated, low strength or delaminated is removed faster than the surrounding sound concrete by the water jet. For example, if the average removal depth is 2 in. (50 mm) and there is a delamination that is 2 in. (50 mm) deep, the actual removal within the delaminated area could be 3 to 4 in. (75 to 100 mm) deep. For this reason, removal in an area that is seriously deteriorated and delaminated may not be consistent.

This effect is often described as "selective removal of deteriorated concrete." While the water jet is traversing and advancing uniformly over the surface, it is removing unsound, delaminated, deteriorated, cracked, and low strength concrete selectively below the specified removal depth.

Selective removal is not without limitations. For example, if the robot is traversing and advancing rapidly as during scarification, it may not remove deeper delaminations.

Size and spacing of the reinforcing steel will also influence the removal depth. The reinforcing steel blocks the water jet and shields the concrete below, creating concrete "shadows" (Fig. 22 and 23). Removal of concrete shadows becomes more difficult as the reinforcing bar size increases and

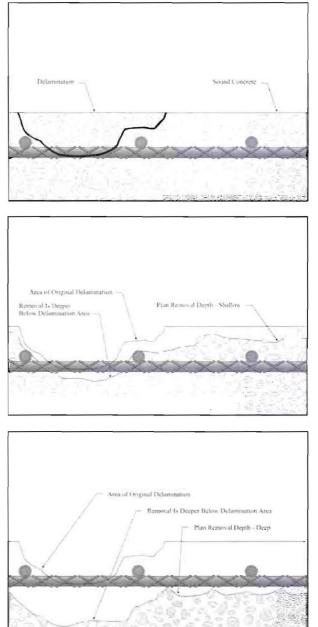


Fig. 21: Delaminated or deteriorated concrete is removed at a faster rate leading to non-uniform removal

is most difficult at reinforcing bar intersections. Increasing the specified depth of removal will minimize the amount of shadowing.

Pointing the water jet under the reinforcing bar can reduce concrete shadows. This can be accomplished by using a rotating or oscillating nozzle (refer to Fig. 7-9). Rotating nozzles are typically angled 10° and 30° from center. The nozzle rotates between 100 and 1800 rpm, creating a demolition cone that will undercut both the transverse and parallel reinforcing bar provided the specified removal depth is greater than the

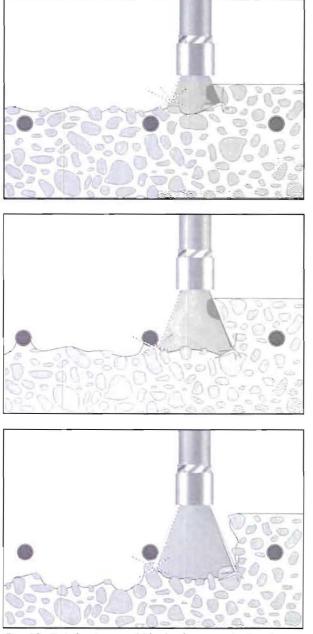


Fig. 22: Reinforcing steel blocks the water jet leaving a concrete "shadow" under the reinforcing. Increasing the removal depth will decrease the amount of shadowing

depth of the reinforcing bar. Similarly, the oscillating nozzle moves from side to side as it traverses, directing the water jet at an angle to the surface, cutting under the reinforcing bar. The nozzle is angled forward as it traverses left, and at the end of the traverse, flips to face forward as it traverses right. To minimize concrete shadows, the required depth of removal should be at least 3/4 in. (19 mm) below a #5 reinforcing bar. Larger reinforcing bars will require a greater removal depth to minimize shadowing. While this additional

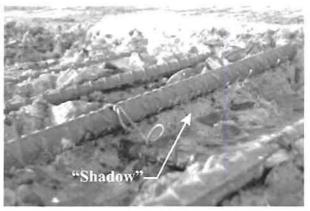


Fig. 23: "Shadow" under the rebar (note tie wire undamaged and in excellent condition)

removal may result in the removal of sound concrete, it will minimize the need for concrete removal under the reinforcing bar with chipping hammers or hand lances.

Considerations for Hydrodemolition Use

Issues that should be considered when evaluating the use of hydrodemolition for a repair project include:

Limited quantity of repair: Mobilization and set up of the hydrodemolition equipment can be expensive. If there are only minor repairs or a limited quantity of repairs, the mobilization cost may make the process uneconomical.

Increase in repair quantity: The traverse and advance function of the hydrodemolition robot results in removal areas that are rectangular. The removal areas may have to be "squared up" in order for the hydrodemolition equipment to efficiently remove the concrete. "Squaring up" the repair areas may lead to an increase in the removal quantity and the cost of the project.

Reinforcing bar size and concrete cover: Partial-depth removal normally requires clearance below the bottom reinforcing bar of the top mat of reinforcing. The size and quantity of the reinforcing bar and the concrete cover over the reinforcing bar should be determined in order to specify the correct removal depth to achieve the required clearance.

Potential for full-depth blow-throughs: Hydrodemolition of severely deteriorated structures may result in full-depth blow-throughs. Blowthroughs may take place where full depth slab cracks occur, especially if deterioration is evident on the slab underside. Shielding may be required to protect the area below from damage. Shoring below the blow-through may be damaged or destroyed. When the water jet is in the open air, as will happen when the water jet blows through the deck, it is extremely noisy (may exceed 130 db) and dangerous. Sound resistant partitions should be installed to contain the noise within the structure if blow-throughs are expected.

Extent of previous repairs: Repair materials may have a different compressive strength than the original concrete. Since the hydrodemolition jet is set to move at a uniform rate, the presence of dissimilar strengths of material will result in a variation in the depth of removal. Higher strength areas may require further concrete removals using chipping hammers or hand lances to achieve the specified depth of removal. Lower strength areas may result in deeper removals and possibly full-depth blow-throughs.

Occupied areas adjacent to or under the repair area: Occupied spaces such as stores or offices may occur in the structure. It may not be practical to perform hydrodemolition adjacent to or over these areas. Water from the hydrodemolition may leak to the occupied level below. As such, the repair area should be protected to prevent water from entering the occupied area.

Shoring requirements: During structural repairs, concrete may be removed from around the top reinforcing. An analysis of the structural capacity of the remaining slab section should be made by a qualified engineer to determine if shoring will be required. The weight of the hydrodemolition robot should be considered when determining shoring requirements.

Equipment location: The hydrodemolition equipment is transported on a trailer. If possible, the pumps should be located within 300 ft of the repair area. A suitable location next to the structure must be selected. Pump units that are powered by diesels engines should not be located next to the air intake of adjacent buildings. In congested metropolitan areas, the pumps may be removed from the trailer and placed within the structure. Diesel powered pumps will need to be located close to an exhaust shaft and the exhaust from the pumps piped to this location. A fuel tank will also have to be placed in the pump area and provisions made to fill the tank as required. Although electric pumps may be used inside the structure eliminating the fueling and exhaust concerns, they have a substantial power requirement and will need an electrical service installed. Due to the weight of the pumps, they may need to be placed on the slab on ground or in a shored area

of the structure. Temporary shoring may be needed to move the pumps into the structure.

Available water sources: Pumps used for hydrodemolition require a steady supply of clean water at a sufficient volume to perform the work. Generally, local municipal water is used for hydrodemolition. Sources close to the work area, such as a nearby fire hydrant or water line feeding the structure, should be adequate. Specific water requirements will vary, depending on the hydrodemolition unit used for the project and the method of cleanup. Cleanup performed using a fire hose operating at 100 to 200 gpm (380 lpm to 760 lpm) will use substantially more water than an 8000 to 10,000-psi (55 to 70 MPa) water blaster operating at 8 to 12 gpm (30 to 45 lpm). In remote areas, water can be drawn from wells, fresh water lakes, rivers, or streams. This water must be pre-filtered to remove any suspended solids to avoid damage to the high-pressure pumps. Recycled water has been used for hydrodemolition, however, it can add substantially to the cost of the project due to collection and filtration of the water and the added wear to the equipment caused by dissolved minerals in the recycled water. When available, potable water is used. Water may have to be trucked into remote locations.

Post-tensioned structures: The use of hydrodemolition on post-tensioned structures has potentially severe risks and must be carefully evaluated to maintain a safe working environment, maintain structural integrity, and to preserve the long-term durability of the structure. Sudden release of anchorages can result in dangerous explosive energy and flying debris capable of causing damage to equipment and serious injury or death to workers. Tendons should be de-tensioned prior to removing concrete from around anchorages to prevent the sudden release of the anchorages and loss of pre-stress forces. The loss of pre-stress forces may result in the loss of structural integrity and result in the need for shoring. Careful evaluation must also be exercised when removing concrete around post-tensioning tendons. Removal of concrete around tendons can result in a change of tendon profile, which may also result in the loss of prestressing force and structural integrity.

The wires or strands of post-tensioning tendons are usually undamaged during hydrodemolition, however the sheathing and protective grease will be removed from unbonded tendons. In bonded post-tensioning tendons, the water jet may penetrate the duct and remove the grout inside. In either case, the hydrodemolition water may enter the tendon at the edge of the repair area and can be driven into the tendon outside the work area. Water remaining in the tendon can cause future corrosion affecting the long-term durability of the post-tensioning system. Each tendon must be carefully examined and any water that has entered the tendon removed. Both the grease and the

protective sheathing must be restored. It may not be possible to remove moisture that has entered the post-tensioning system during the hydrodemolition process. In addition, verification of the presence of moisture is difficult and may not be possible. Refer to ICRI Technical Guideline No. 03736, "Guide for the Evaluation of Unbonded Post-Tensioned Concrete Structures," for suggested procedures to detect water in posttensioning tendons. Long term monitoring for future corrosion may also be prudent.

Conduit and embedded metal items: Embedded aluminum and steel conduit will not be damaged by hydrodemolition if they are in good condition. However, deteriorated portions of aluminum and steel conduit will be damaged and water will enter the conduit system. PVC conduit will be damaged during hydrodemolition. As a safety precaution, all conduits should be deenergized during demolition. Other metal items within the removal area such as shear connectors, shear studs, and anchorages will not be damaged by hydrodemolition.

Noise limitations: Hydrodemolition does not produce sound that is transmitted through a structure, however, the noise from the hydrodemolition unit in the work area is sufficiently loud to be objectionable to the public. Furthermore, noise can be excessive during full-depth repairs or blow-throughs. Sound reducing partition walls that separate the public from the work area may be required. Acoustical studies indicate that the sound waves created by hydrodemolition are low frequency and are best controlled using dense material such as sheet rock or concrete board. There are a variety of sound deadening materials supplied by various vendors that have proven effective in controlling noise. Partition walls should be protected from moisture. If properly sealed at the base, a water resistant sound reducing partition wall will also assist in containing the water within the work area.

Protection of lighting, sprinklers, and other services: Light fixtures, fire protection systems, and other services may be damaged by airborne debris from the hydrodemolition or clean up operation. If full depth removal or blow-throughs are anticipated, light fixtures may need to be removed and stored and temporary lighting installed. Sprinkler heads may need to be protected. Mist and high humidity in the work area could damage electrical panels and other services. Items remaining in the work area should be protected.

Temperature: When the temperature falls below freezing, the structure must be heated or the hydrodemolition stopped to prevent water from freezing in the work area.

Test Area

A test area should be designated to establish the operating parameters and to demonstrate that the equipment, personnel, and methods of operation are capable of producing satisfactory concrete removal results. The test should include sound and deteriorated concrete areas, each a minimum of 50 ft² (5 m²). First the robot is set to remove sound concrete to the specified depth. Once the operating parameters have been determined, the equipment is moved to the deteriorated area and a second test is performed using the same operating parameters. If satisfactory results are achieved, the quality and depth of removal will become the standard for the project. If hand lances are to be used to perform concrete removals, they should also be demonstrated to show satisfactory results.

It is noted that the hydrodemolition robot will move the water jet over the surface in a constant motion and if the concrete is of uniform strength, the removal depth will be consistent. However, since concrete is seldom uniform, there will be variations in the removal depth on the project. Other factors affecting the removal depth include the extent and depth of deterioration, the size and quantity of reinforcing bar, the concrete cover over the reinforcing bar, and the presence of surface hardeners. As the equipment is used, nozzles will wear, changing the force created by the water jet. As such, the hydrodemolition equipment operator must monitor the depth and quality of removal and adjust the parameters of the robot to provide consistent removal throughout the project.

Wastewater Control

Controlling the wastewater has often been viewed as one of the more difficult tasks associated with the use of hydrodemolition. However, with preplanning and proper installation of a wastewater control system, the water can be properly managed (Fig. 24). Hydrodemolition wastewater should be

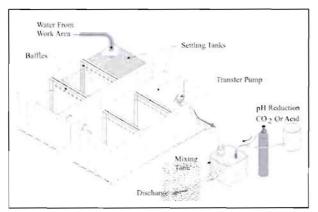


Fig. 24: Typical wastewater handling system

discharged to the storm or sanitary sewer or to the ground for absorption and/or evaporation under permit from the controlling authority. Discharge into an existing storm or sanitary line may occur in the structure or to a nearby storm or sanitary line accessed through a manhole. A 4-in. (100 mm) connection should be adequate. Wastewater may not be discharged directly to a wetland, stream, river or lake.

Hydrodemolition wastewater contains suspended particles and typically has a pH of 11 to 12.5. The wastewater is initially placed in settling tanks or ponds to reduce the suspended solids. The particles are heavy and settle out quickly as the water is allowed to stand. This can also be accomplished by allowing the water to pass through a series of berms that are lined with filter fabric or hay bales.

The controlling authorities for discharge have varying requirements for the level of suspended solids and the range of pH for discharge into their system. Typically the water should be clear and the pH range between 5 and 10. Ponding the water will clarify it, however, the pH of the wastewater may have to be reduced prior to discharge. This can be accomplished by the introduction of acid, CO_2 or other pH reducing materials into the wastewater. Adding flocculants can assist in reducing suspended solids. A location for settling ponds or tanks and pH reducing equipment should be determined.

The cost to discharge wastewater ranges from the cost of a discharge permit to charges for the actual water consumed and discharged. The cost of water consumed is generally that of commercial water usage within the community. The controlling authority may require monitoring and testing of the wastewater. Local ordinance requirements must be reviewed and met prior to discharge, including the obtaining of proper permits.

Water containment and collection systems will vary depending on the structure. Where possible, it is best to take advantage of gravity to move the water to the treatment area. In many structures, the slab on ground can be used to collect and treat the water. The water may be allowed to flow through the structure to the lowest level or through the existing drains, which have been disconnected just below the underside of the first supported level. All slab-on-ground drains should be plugged and water should not be allowed to enter the drainage system prior to treatment. Once the water is clear and the pH adjusted, it can be pumped directly to the discharge point. Additional treatment capacity may be necessary if rainwater cannot be separated from the wastewater.

Floor slabs and decks are commonly crowned or sloped to provide drainage. Since water will run to the low area, a simple method of water control involves the use of hay bales or aggregate dams, which can be set up along curb lines or the perimeter of the work area. As the water ponds in front of the hay bales or aggregate dams, the suspended solids will settle out. In areas where the drains are plugged, the water is forced to pass through the hay bales or aggregate dams. Retention ponds can be built at the end of the structure and the water directed or pumped to these ponds. Settling tanks can also be used and the water pumped from the structure to the tanks.

Debris Cleanup and Disposal

Hydrodemolition debris consists of wet sand, aggregate, chips or chunks of concrete, and slurry water. Slurry contains cement particles and ranges from muddy water to a thick paste. Removal of the debris should occur as soon as possible to prevent the debris from solidifying and adhering to the surface, making cleanup more difficult.

Tools used for cleanup include: fire hoses, pressure washers, compressed air, sweepers, skid steer loaders, vacuum trucks, and manual labor.

The types of cleanup will vary based on the type of removal performed as follows:

- 1. Above the reinforcing bar—any removal depth above the top reinforcing bar of the top mat of reinforcing and the reinforcing bar remains supported by the concrete;
- Below the reinforcing bar—any removal depth below the top mat of reinforcing bar in which the top reinforcing bar mat becomes unsupported by the original concrete; and

3. Full-depth removal.

During *above the reinforcing bar* clean up, equipment such as skid steer loaders, sweepers, and vacuum trucks may be driven over the surface to assist with the cleanup (providing they meet the weight requirements of the structure). The debris can be swept, pressure washed or air blown into piles where it is picked up by a loader. A vacuum truck may be used to vacuum the debris from the surface. In all cases, the surface must be pressure washed to remove any remaining cement slurry.

If the removal is *below the reinforcing bar* and the reinforcing bar is unsupported, it is difficult and possibly unsafe to drive equipment into the removal area. The debris can be removed by washing with a fire hose (large water consumption), pressure washing or blowing it onto the adjacent original surface where it can be picked up with a loader. A pressure washer operating at 8000 to 10,000 psi (55 to 70 MPa) and 8 to 12 gpm (30 to 45 lpm) is effective. Vacuuming has proven very effective in removing debris from around the reinforcing steel, however, the surface will require pressure washing to remove the cement slurry and paste.

During *full-depth removal*, the debris simply falls to the floor below where it can be picked up with a loader.

The debris, which consists of wet sand, aggregate, chips or chunks of concrete, and slurry is placed in dumpsters or hauled away in trucks and may be recycled or placed in a landfill in accordance with the requirements of the controlling authority.

Removal Depth Measurements

Following hydrodemolition, the surface profile is very rough and three depth measurements are possible (Fig. 25):

- 1. Minimum removal—original surface to the shallowest removal point.
- 2. Maximum removal—original surface to the deepest removal point.
- 3. Average depth of removal—The difference between the minimum and maximum removal at the same location.

Measuring the depth of removal can be accomplished using:

- 1. A straight-edge placed on the original surface;
- 2. A string-line pulled over the removal area; and
- 3. A surveyor's level.

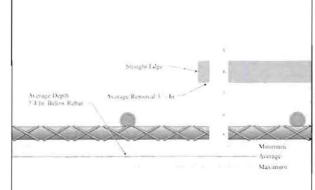


Fig: 25: Measuring depth of removal using a straight edge

The most common practice of measuring the depth of removal is to place a straightedge on top of the original surface and extend it over the removal area. Measurements are taken from the bottom of the straightedge to determine the depth of removal. This quick and simple technique can only be used during the removal process and is not applicable for final measurements in large removal areas.

A string line may be pulled over the removal area and measurements taken below the string. However, this method could provide incorrect results if slopes or crowns occur in the original surface. Surveying equipment may be used and is very accurate; however, to account for slopes, pitches and crowns in the original surface, a detailed survey must be made of the original surface prior to removal and measurements taken at the same locations after removal for comparison and determination of the actual removal depth.

Summary

Effective concrete removal and proper surface preparation are key elements to a successful repair project. A surface prepared using hydrodemolition is rough, irregular, and is excellent in creating a mechanical bond with the repair material. Hydrodemolition eliminates micro-fractures and damage to reinforcing steel, minimizes transmitted noise and dust, and cleans the reinforcing steel.

The use of hydrodemolition may not be appropriate for every structure and a careful review of the benefits and limitations of the process relative to each structure should be undertaken. Proper safety procedures must be observed at all times when using hydrodemolition.



Exhibit 22: ACI 546R-04

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