CENTER OF EXCELLENCE FOR AIRPORT TECHNOLOGY

TECHNICAL NOTE

TECH NOTE NO:	2
TITLE:	PCC Mix Design
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1. Introduction

This technical note presents recent concrete mixes and measured properties used at the Chicago O'Hare Airport along with other concrete mixes used at airports in the midwest and west coast. The purpose of this information is to document typical mixes used at O'Hare as a starting point in order to develop optimum concrete mixes for the O'Hare Modernization Program.

2. Mix Design and Properties of Concrete used on a prior O'Hare Project (2000 & 2004)

Concrete mix design and strength information was compiled by Alan Dadian of the City of Chicago and delivered to CEAT for review. Table 1 shows the most common mixes used at O'Hare in 2000 were #1905 and #1994 and mix K-5 003-00 in 2004.

These mixtures are very similar in terms of their low water cementitious (WCM) ratio and high cement and fly ash content, 569 and 120 lb on average, respectively. All mixes achieved a modulus of rupture (MOR) over 750 psi at 28 days and achieved 87% of the 28-day MOR at 7 days on average (where information is available). Only one mix used steel fibers, but there was no MOR data available.

3. Mix Design and Properties of Concrete used on other Airport Projects

Table 2 presents concrete mixtures used at the St. Louis Lambert Airport, Capital Airport in Springfield, IL, Fort Wayne Airport (Indiana), and two airport mixes from California.

Two group of mixes can be identified on the St. Louis Airport. One group that include mixes 1F, 4F and 4F with fibers, that had an average cement and fly ash content of 527 and 80 lb, respectively, with an average 28-day MOR of 929 psi and WCM ratio of 0.42.

Another group include mixes 3F, 5F and 5 F with fibers, with an average cement, GGBFS and fly ash content of 337, 92 lb and 184 lb, respectively, with an average 28-day MOR of 681 psi and WCM ratio of 0.42.

The mixes used in Fort Wayne and California Airports focused on lower cement contents and optimal coarse aggregate gradation. Little strength information was available so no further comments can be made about these mixes relative to the O'Hare standard mixes.

5. Final Remarks

The concrete mix designs typically used at O'Hare have similar proportions. The strengths achieved at 7-days exceed the design strength assumed in the concrete thickness calculation. Other airports in the Midwest such as St. Louis have achieved high flexural strength values exceeding the design MOR substantially.

Table 1. Typical mixes used in recent projects at O'Hare Airport.

Mix Id.	Proposed Mix #1905 (2000)	Revised Mix #1905 (2000)	Mix #1933 (2000)	Proposed Mix #1994 (2000)	Mix K-5 003-00 (2004)	Units
Water	280	262	280	262	258	lb/yd3
Type I Cement	541	588	588	588	541	lb/yd3
Type C Fly Ash	135	100	100	130	135	lb/yd3
Coarse aggregate (# 57 Limestone, 1" max size.)	1850	1850	1850	1800	1840	lb/yd3
Fine aggregate	1125	1103	1115	1100	1117	lb/yd3
Steel Fibers	0	0	0	85	0	lb/yd3
Air entrainment admixture (Excel Air)	N/A	7	N/A	N/A	6.8	oz/yd3
Water Reducer (Excel Redi Set)	29	15	28	29	30.4	oz/yd3
Properties	**Proposed Mix #1905**	**Revised Mix #1905**	**Mix #1933**	**Proposed Mix #1904**	**Mix K-5 003-00**	**Units**
W/CM	0.41	0.38	0.41	0.36	0.38	-
fr7	N/A	788	802	N/A	770	psi
fr28	N/A	1030	842	N/A	855	psi
Air	5-8	5-8	5-7	5-8	6.2	%
Slump	2	3 +/- 1	3 +/- 1	3 +/- 1	1	in

Table 2. Concrete mixes used on other Airport projects.

Airport	Capital Airport	St. louis Lambert	St. louis Lambert	St. louis Lambert	St. louis Lambert	St. louis Lambert	St. louis Lambert	St. louis Lambert	St. louis Lambert	Fort Wayne	Californ ia	Califor nia	
Mix Id.	**N/A**	**Mix 1 F**	**Mix 4 F**	**Mix 4 F w/ fibers**	**Mix 3 F**	**Mix 5 F**	**Mix 5 F w/fibers**	**Mix 6 F**	**Mix P 5**	**Mix 1**	**Mix 1**	**Mix 2**	
Water	233	250	258	258	248	258	258	258	250	218	300	258	lb/yd3
Cement	490	510	535	535	354	310	310	372	680	288	489	479	lb/yd3
Type C Fly Ash	150	80	80	80	88	93	93	93	-	192	122	85	lb/yd3
GGBS	-	-	-	-	148	217	217	155	-	-	-	-	lb/yd3
Coarse aggregate #1	1842	1866	1834	1834	1872	1808	1808	1836	1790	1424	1570	1400	lb/yd3
Coarse aggregate #2	-	-	-	-	-	-	-	-	-	615	400	475	lb/yd3
Fine aggregate	1156	1225	1220	1220	1228	1232	1232	1206	1280	1198	1165	1310	lb/yd3
Fibers	-	-	-	3	-	-	3	-	-	-	-		lb/yd3
Air entrainment admixture	N/A	5.6	5.6	5.6	3	3.1	3.1	3.1	N/A	N/A	N/A	1.7	oz/yd3
Water Reducer	19.6	14.2	14.2	14.2	17.7	18.6	18.6	18.6	N/A	N/A	N/A	16.92	oz/yd3
Materials Properties													
Cement Type	**I**	**I**	**I**	**I**	**I**	**I**	**I**	**I**	**I**	**I**	**I**	**II**	
Coarse aggregate # 1 max. size. (in)	N/A	3/4" (#67)	3/4" (#67)	3/4" (#67)	3/4" (#67)	3/4" (#67)	3/4" (#67)	3/4" (#67)	3/4" (#67)	1" (57)	1" (57)	1" (57)	
Coarse aggregate # 2 max. size. (in)	-	-	-	-	-	-	-	-	-	3/8"	3/8"	1/2 x #4"	
Fine aggregate type	N/A	River Sand	River Sand	River Sand	River Sand	River Sand	River Sand	River Sand	River Sand	N/A,FM = 2.68	N/A,FM = 2.96	Sechelt Sand	
AEA type	AEA Grace	Polychen AE VRC	Polychen AE VRC	Polychen AE VRC	Polychen AE VRC	Polychen AE VRC	Polychen AE VRC	Polychen AE VRC	GRT AEA	N/A	N/A	MBAE	
WR type	Daracem Grace	Polychen MC 400	Polychen MC 400	Polychen MC 400	Polychen MC 400	Polychen MC 400	Polychen MC 400	Polychen MC 400	GRT KB 1000	N/A	N/A	Pozz 200N	
Fiber type	-	-	-	GRT Polymesh fibers	-	-	GRT Polymesh fibers	-	-	-	-	-	
Concrete Properties													**Units**
W/CM	**0.36**	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**	**0.37**	**0.45**	**0.49**	**0.46**	**-**
fr28	770	1033	850	905	700	675	675	675	1280	N/A	N/A	767	psi
Air	5.5	7.6	7	7	5	5	5	5	6	N/A	N/A	3	%
Slump	4 1/2"	2"	3 3/4 "	3 3/4 "	1 1/4 "	3"	3"	3"	1 1/2"	N/A	N/A	3 1/4"	in