RIVER BEND, SALEM
CONCRETE CYLINDER MOLD INVESTIGATION
PHASE ONE REPORT

FEBRUARY 23, 1987

STUDY MADE BY
OREGON STATE HIGHWAY DIVISION
MATERIALS SECTION

W. J. UPTON
LABORATORY TECHNICIAN

Department of Transportation

HIGHWAY DIVISION

Materials Section

DOCUMENT NUMBER 00008

Technical Report Documentation Page

Specification No.	ODOT No.
504	
Report Date	**Report No.**
February 23, 1987	

Title

River-Bend, Salem
Concrete Cylinder Mold Investigation
Phase One Report

Subtitle

Author

W.J. Upton - Laboratory Technician

Performing Organization

Materials Section
Oregon State Highway Division
2950 State Street
Salem, OR 97310

Sponsoring Agency

Notes

Key Words	Type
Concrete Cylinder Molds Compressive Strength Portland Cement Concrete	Research Report
	Location

INTRODUCTION

OSHD Materials Section has been involved in an on going investigation of differences in compressive strength between plastic and steel cylinder molds. All prior comparisons have been made using high strength concrete from prestress yards. In this report the comparison is being made using a low strength (4.67 sack 3000 3/4) concrete mix. The guideline for selecting and preparing cylinder molds will be AASHTO M205-83 (ASTM C470-81)

PURPOSE

The purpose of this study is to examine through laboratory testing if there is a significant difference in compressive strengths between cylinders cast in plastic molds and steel molds.

SCOPE

For laboratory analysis, two sets of sixteen cylinders were cast from a single batch of well-mixed concrete produced by River Bend Sand and Gravel in Salem. The well-mixed single batch of concrete was used to insure uniformity. The compressive strength testing was performed at OSHD Materials Laboratory in Salem.

The test results were analyzed statistically at a 95% significance level. This was done by calculating the mean difference and the standard error of the difference between the mean of the two populations. Values from the area under the normal probability curve are compared to the accepted convention.*1 A significant result is a calculated probability less than 0.05, and a highly significant result is a calculated probability less than 0.01. The standard deviation was calculated with (n-1),number of samples in the set, as the denominator. This was done to be consistent with ACI 301-84 and ACI 318-83.

*1 Probability and Statistics by Alder/rossler, 1975, 6th edition

PROCEDURE

During the week prior to January 21, 1987 sixteen steel cylinder molds were cleaned, sealed, and oiled.

On January 21, 1987 a class 3000 3/4 inch 4.67 sack mix proportioned and produced by River Bend Sand and Gravel was obtained. From this concrete two sets of sixteen cylinders were fabricated alternating between plastic and steel molds to ensure uniformity. The molded cylinders were immediately placed in a moist cure room and covered, the plastic molds with lids provided by the manufacturer, and the steel with glass plates.

Initial cure (first 24 hours) for the cylinders was completed in the OSHD Materials laboratory moist cure room at a regulated temperature of 73.4 $\pm$ 3 degrees F. After the initial cure the cylinders were removed from the moist cure room and demolded. All cylinders were capped with sulfur mortar caps and returned to the moist cure room until February 18, 1987.

On February 18, 1987 the cylinders were tested for 28 day compressive strength according to AASHTO T22-84I (ASTM C39-81). The cross sectional area of each cylinder was determined by an average of two micrometer readings at the midpoint. This area was used to calculate the compressive strength of the cylinders.

TEST RESULTS

Compressive strength test results are listed on Table 1. Also shown on Table 1 is the population, mean, standard deviation, and standard error for each of the two groups.

A statistical analysis between the two sets of cylinders is listed on Table 2. The calculations show a mean difference of 6.54 percent between cylinders cast in plastic and steel molds. This is a highly significant difference with a value of 0.0012.

CONCLUSION

The test result in this portion of the investigation of plastic molds vs steel molds does show a statistical difference in compressive strengths. This same result has been found in both high strength and low strength concrete. Although there is a difference in the compressive strengths, test results do not indicate which compressive strength results are the most representive of the actual potential strength of the concrete mixes.

Currently OSHD is using plastic single-use cylinder molds for all acceptance testing. No change in our policy is recommended at this time after reviewing this test data.

COMPRESSIVE STRENGTH OF CYLINDERS

TABLE I

	PLASTIC	STEEL
	4320	4090
	4090	4260
	3920	4270
	4060	4540
	4410	4460
	4230	5010
	4380	3940
	4350	4150
	4410	4660
	4210	4500
	3950	4880
	3790	4930
	4480	4610
	4240	4630
	4390	4610
	4230	4640
POPULATION	16	16
MEAN	4220	4510
STD. DEV.	202.0	304.6
STD. ERROR	50.50	76.15

STATISTICAL COMPARISON

TABLE II

MEAN DIFFERENCE	290
PERCENT MEAN DIFFERENCE	6.54
STANDARD ERROR (OF MEAN DIFFERENCE)	91.37
RATIO	3.23
AREA FROM TABLES	0.4494
(0.5 - AREA)2	0.0012
SIGNIFICANCE	HIGHLY

ILLUSTRATION #1

Table I
Areas Under the Normal Probability Curve

The entries under *A* denote the area between the line of symmetry (that is, $z = 0$) and the given z-value.

z	*A*	*z*	*A*	*z*	*A*	*z*	*A*
0.00	0.0000	0.30	0.1179	0.60	0.2258	0.90	0.3159
.01	.0040	.31	.1217	.61	.2291	.91	.3186
.02	.0080	.32	.1255	.62	.2324	.92	.3212
.03	.0120	.33	.1293	.63	.2357	.93	.3238
.04	.0160	.34	.1331	.64	.2389	.94	.3264
.05	.0199	.35	.1368	.65	.2422	.95	.3289
.06	.0239	.36	.1406	.66	.2454	.96	.3315
.07	.0279	.37	.1443	.67	.2486	.97	.3340
.08	.0319	.38	.1480	.68	.2518	.98	.3365
.09	.0359	.39	.1517	.69	.2549	.99	.3389
.10	.0398	.40	.1554	.70	.2580	1.00	.3413
.11	.0438	.41	.1591	.71	.2612	1.01	.3438
.12	.0478	.42	.1628	.72	.2642	1.02	.3461
.13	.0517	.43	.1664	.73	.2673	1.03	.3485
.14	.0557	.44	.1700	.74	.2704	1.04	.3508
.15	.0596	.45	.1736	.75	.2734	1.05	.3531
.16	.0636	.46	.1772	.76	.2764	1.06	.3554
.17	.0675	.47	.1808	.77	.2794	1.07	.3577
.18	.0714	.48	.1844	.78	.2823	1.08	.3599
.19	.0753	.49	.1879	.79	.2852	1.09	.3621
.20	.0793	.50	.1915	.80	.2881	1.10	.3643
.21	.0832	.51	.1950	.81	.2910	1.11	.3665
.22	.0871	.52	.1985	.82	.2939	1.12	.3686
.23	.0910	.53	.2019	.83	.2967	1.13	.3708
.24	.0948	.54	.2054	.84	.2996	1.14	.3729
.25	.0987	.55	.2088	.85	.3023	1.15	.3749
.26	.1026	.56	.2123	.86	.3051	1.16	.3770
.27	.1064	.57	.2157	.87	.3078	1.17	.3790
.28	.1103	.58	.2190	.88	.3106	1.18	.3810
.29	.1141	.59	.2224	.89	.3133	1.19	.3830

ILLUSTRATION #2

Table I. Areas Under the Normal Probability Curve
(continued)

z	A	z	A	z	A	z	A
1.20	0.3849	1.55	0.4394	1.90	0.4713	2.25	0.4878
1.21	.3869	1.56	.4406	1.91	.4719	2.26	.4881
1.22	.3888	1.57	.4418	1.92	.4726	2.27	.4884
1.23	.3907	1.58	.4430	1.93	.4732	2.28	.4887
1.24	.3925	1.59	.4441	1.94	.4738	2.29	.4890
1.25	.3944	1.60	.4452	1.95	.4744	2.30	.4893
1.26	.3962	1.61	.4463	1.96	.4750	2.31	.4896
1.27	.3980	1.62	.4474	1.97	.4756	2.32	.4898
1.28	.3997	1.63	.4485	1.98	.4762	2.33	.4901
1.29	.4015	1.64	.4495	1.99	.4767	2.34	.4904
1.30	.4032	1.65	.4505	2.00	.4773	2.35	.4906
1.31	.4049	1.66	.4515	2.01	.4778	2.36	.4909
1.32	.4066	1.67	.4525	2.02	.4783	2.37	.4911
1.33	.4082	1.68	.4535	2.03	.4788	2.38	.4913
1.34	.4099	1.69	.4545	2.04	.4793	2.39	.4916
1.35	.4115	1.70	.4554	2.05	.4798	2.40	.4918
1.36	.4131	1.71	.4564	2.06	.4803	2.41	.4920
1.37	.4147	1.72	.4573	2.07	.4808	2.42	.4922
1.38	.4162	1.73	.4582	2.08	.4812	2.43	.4925
1.39	.4177	1.74	.4591	2.09	.4817	2.44	.4927
1.40	.4192	1.75	.4599	2.10	.4821	2.45	.4929
1.41	.4207	1.76	.4608	2.11	.4826	2.46	.4931
1.42	.4222	1.77	.4616	2.12	.4830	2.47	.4932
1.43	.4236	1.78	.4625	2.13	.4834	2.48	.4934
1.44	.4251	1.79	.4633	2.14	.4838	2.49	.4936
1.45	.4265	1.80	.4641	2.15	.4842	2.50	.4938
1.46	.4279	1.81	.4649	2.16	.4846	2.51	.4940
1.47	.4292	1.82	.4656	2.17	.4850	2.52	.4941
1.48	.4306	1.83	.4664	2.18	.4854	2.53	.4943
1.49	.4319	1.84	.4671	2.19	.4857	2.54	.4945
1.50	.4332	1.85	.4678	2.20	.4861	2.55	.4946
1.51	.4345	1.86	.4686	2.21	.4865	2.56	.4948
1.52	.4357	1.87	.4693	2.22	.4868	2.57	.4949
1.53	.4370	1.88	.4700	2.23	.4871	2.58	.4951
1.54	.4382	1.89	.4706	2.24	.4875	2.59	.4952

ILLUSTRATION #3

Table I. Areas Under the Normal Probability Curve
(concluded)

z	A	z	A	z	A	z	A
2.60	0.4953	2.95	0.4984	3.30	0.4995	3.65	0.4999
2.61	.4955	2.96	.4985	3.31	.4995	3.66	.4999
2.62	.4956	2.97	.4985	3.32	.4995	3.67	.4999
2.63	.4957	2.98	.4986	3.33	.4995	3.68	.4999
2.64	.4959	2.99	.4986	3.34	.4995	3.69	.4999
2.65	.4960	3.00	.4987	3.35	.4996	3.70	.4999
2.66	.4961	3.01	.4987	3.36	.4996	3.71	.4999
2.67	.4962	3.02	.4987	3.37	.4996	3.72	.4999
2.68	.4963	3.03	.4988	3.38	.4996	3.73	.4999
2.69	.4964	3.04	.4988	3.39	.4997	3.74	.4999
2.70	.4965	3.05	.4989	3.40	.4997	3.75	.4999
2.71	.4966	3.06	.4989	3.41	.4997	3.76	.4999
2.72	.4967	3.07	.4989	3.42	.4997	3.77	.4999
2.73	.4968	3.08	.4990	3.43	.4997	3.78	.4999
2.74	.4969	3.09	.4990	3.44	.4997	3.79	.4999
2.75	.4970	3.10	.4990	3.45	.4997	3.80	.4999
2.76	.4971	3.11	.4991	3.46	.4997	3.81	.4999
2.77	.4972	3.12	.4991	3.47	.4997	3.82	.4999
2.78	.4973	3.13	.4991	3.48	.4998	3.83	.4999
2.79	.4974	3.14	.4992	3.49	.4998	3.84	.4999
2.80	.4974	3.15	.4992	3.50	.4998	3.85	.4999
2.81	.4975	3.16	.4992	3.51	.4998	3.86	.4999
2.82	.4976	3.17	.4992	3.52	.4998	3.87	.5000
2.83	.4977	3.18	.4993	3.53	.4998	3.88	.5000
2.84	.4977	3.19	.4993	3.54	.4998	3.89	.5000
2.85	.4978	3.20	.4993	3.55	.4998		
2.86	.4979	3.21	.4993	3.56	.4998		
2.87	.4980	3.22	.4994	3.57	.4998		
2.88	.4980	3.23	.4994	3.58	.4998		
2.89	.4981	3.24	.4994	3.59	.4998		
2.90	.4981	3.25	.4994	3.60	.4998		
2.91	.4982	3.26	.4994	3.61	.4999		
2.92	.4983	3.27	.4995	3.62	.4999		
2.93	.4983	3.28	.4995	3.63	.4999		
2.94	.4984	3.29	.4995	3.64	.4999		