



Starting Date: 09/1/2005

# Evaluation of Cylinder Strength Correlation

Nebraska Department of Roads

**Research Project Title:**

Evaluation of Cylinder Strength Correlation

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**Principle Investigators:**

Robert Rea  
Assistant Materials & Research Engineer

Wally Heyen  
PCC Engineer

Lieska Halsey  
NDOR Research

**P.C.C Laboratory:**

Gary Mangen  
Highway Quality Assurance Manager



**PURPOSE OF THE INVESTIGATION:**

Currently, NDOR is using 6x12-inch cylinder mold for compressive strength field performance testing. In 2005, due to the increase of research on the strength comparison between 4x8-inch cylinders vs. 6x12-inch cylinders, NDOR started an evaluation for strength comparison in four NDOR's mixes to establish a strength correlation.

**DESCRIPTION OF THE INVESTIGATION:**

1. Evaluate NDOR's paving and structural mixes according to AASHTO T-126 and ASTM C-1231 specifications.
2. Evaluate compressive strength data for 7, 28 and 56 days to establish an average of two specimens per age per mix tested.
3. Evaluate and establish a percent different between the 4x8-inch and the 6x12-inch cylinders and compare results with other studies.

**LABORATORY INVESTIGATION:**

The cylinders were made in the field and were brought to the central lab the next day. The fabrication and curing of all cylinders was conducted according to specifications previously mentioned. The 47B mix design was used in all applications shown in Table 1. The compressive strengths were between 3000 and 3500 psi.

Each mix was composed of six specimens for each 4x8 inch and 6x12 inch cylinders. The concrete plastic characteristics used in the study are shown in Table 1.

Table 1. Concrete Mix Plastic Characteristics

Mix Number (#)	Concrete Type	W/C Ratio	Air Percentage (%)	Compressive Strength (psi)	Cementitious Contents lbs per cy
1	47B	0.412	6.5	3500	564
2	47B	0.423	6.8	3000	564
3	47B	0.436	4.5	3000	564
4	47B	0.414	7.0	3500	564

Compressive strength was collected from the results of 7, 28 & 56 days; respectively, as it is shown graphically in Figure 1.

Figure 1. Compressive strength results

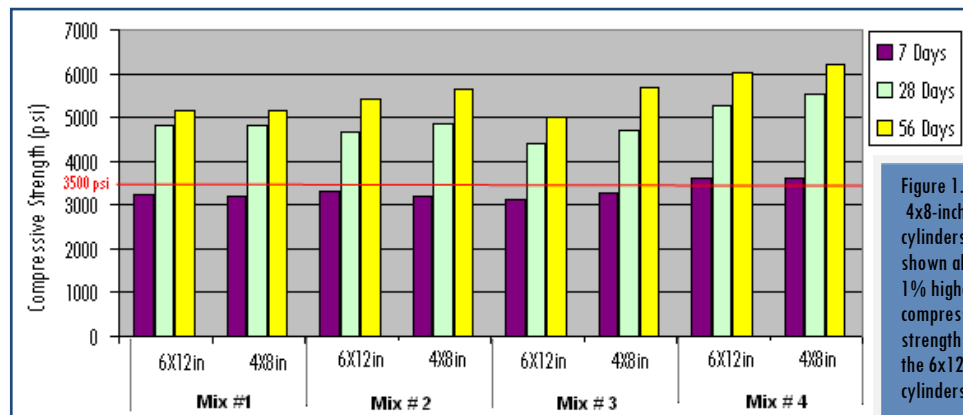


Figure 1. 4x8-inch cylinders have shown about a 1% higher compressive strength than the 6x12-inch cylinders.

**TO DATE INVESTIGATION PROGRESS:**

In 2005, 20 laboratories documented to ASTM the close correlation between the 4x8 and 6x12 inch cylinders in compressive strength. In 2006, ASTM C 31 allowed the use of 4x8 inch cylinders in lieu of 6x12 inch cylinders when job specifications permitted their use. In 2007 through 2009, NDOR followed up with the 2007 ASTM C 31 which stated, "The cylinder diameter shall be at least 3 times the nominal maximum size of the coarse aggregate"; therefore, the largest aggregate size allowed would be 1<sup>5</sup>/<sub>16</sub> inch. NDOR's spec. specifies the coarse aggregate to be used in paving and structures will have a target value of 100% passing with a tolerance of -8% on the 1 inch sieve. NDOR is currently investigating what percent is passing the 1<sup>1</sup>/<sub>4</sub> sieve. Two projects will be selected in the next construction season, to collect more compressive strength data for comparing the 4x8inch and 6x12 inch cylinders. Depending on these results, NDOR may require the 4x8 inch cylinder in lieu of the 6x12 inch cylinder for compressive strength in the future. After an in depth testing and correlation NDOR with several projects was performed and compressive strength data was analyzed. The results were within the 1% deference on the 4x8 inch cylinders.

The Table 2. Shown the evaluation performed in different highways type of projects.

SAMPLE ID#	PROJECT NUMBER	AGE DAYS	COMPRESSIVE STRENGTH LBS /SQ IN CYLINDER SIZE		Percent Average %
			6X12	4X8	
083714170019	STPD-BR-89-3(104)	7	3892	4281	1.10
083714170020	STPD-BR-89-3(104)	7	3565	3697	1.04
083714170029	STPD-BR-89-3(104)	7	3986	3857	0.97
083714170019	STPD-BR-89-3(104)	28	5485	5559	1.01
083714170020	STPD-BR-89-3(104)	28	4878	5483	1.12
083714170029	STPD-BR-89-3(104)	28	4959	5204	1.05
083410540052	NH-30-4(103)	7	3352	3623	1.08
083410540052	NH-30-4(103)	28	4861	5415	1.11
N/A	NH-80-9(837) SCC concrete	7	5060	5620	1.11
N/A	NH-80-9(837) SCC concrete	28	6870	6920	1.01
<b>Average</b>					1.06

Results were comparable for cylinders with  $f'_c < 5000$  psi within Nebraska Department of Roads Class of Concrete. Also, these results correlated with National Studies performed on the subject. Due to the results found Nebraska Department of Roads starting July 1, 2010 4x8 cylinders will be allow to be used on all NDOR & Federally Funded Projects. This change will be reflected in the sampling guide and in Site Manager on July 1, 2010. Therefore, when using 4x8 molds, concrete should be place in the molds in two lifts and rodded 25 times using a 3/8 by 12 inch rod. Also, when testing the 4X8 specimens, 2 cylinders will be made and averaged for one test result. The 6X12 cylinder molds will be discontinued January 1, 2011 for NDOR Staff. For LPA Projects, consultants will still have the option of using 6X12 cylinders. Starting July 1, 2010 4x8 cylinders will be allow to be used on all NDOR & Federally Funded Projects.