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Compressive Strength of Concrete Cylinders by Different Preparation Methods: Sulphur, Neoprene Pads and Grinding

Nebraska Department of Transportation

Research Project:

Compressive Strength of Concrete Cylinders by Different Preparation Methods: Sulphur, Neoprene Pads and Grinding

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Purpose: The purpose of this evaluation is to compare the effects of four types of cylinder preparation methods prior to compressive strength testing in accordance to ASTM C 39. Table 1 shows the concrete cylinder preparation methods.

Table 1

Concrete Cylinder Preparation Method	4 x 8 inch - Cylinders Total per method
Sulphur Capping	30
Neoprene Pads (Nominal Hardness of 50)	30
End Grinding with Bearing Plates	30
End Grinding with Neoprene Pads	30
Total Samples	120

Concrete

All cylinders were cast and cured from four cubic yards of concrete that was delivered from a Ready Mix Plant in Lincoln. The concrete that was used in this research was Class 47B with a design strength of 3500 psi at 28 days. All cylinders were tested at 28 days.

Materials Used in Preparation of Concrete Cylinders

- Sulphur capping compounds were prepared on a strength grade meeting the requirements for cylinder strength of 500 to 7000 psi. The compounds comply with the requirements in ASTM C 617. The thickness of Sulphur cap was strictly controlled within 0.19 to 0.25 inches.
- A new type of rubber pad with a nominal hardness of 50 was used for concrete strength of 60MPa grade.
- Concrete cylinders were ground on the Hi-Kenma (Figure 1) grinding machine, which was manufactured in Japan.



120 cylinders



Figure 1. End Grinding Equipment

Method of Quantification

The results are presented and discussed as follows:

- The mean strength value and type of break observed
- The coefficient of variation (COV)

Effects on the Mean Compressive Strength and the Type of Break Observed

For each preparation method, the mean value was calculated. The mean values from all test methods were then assessed and presented in Table 2. While analyzing the data, two preparation methods were very consistent on the average of the final strength. Those preparation methods were with neoprene pads and end grinding with neoprene pads. In comparison with sulphur capping and end grinding with bearing plates, the data shows a higher compressive strength. Also, it was observed that the final break patterns were described as pattern type 1, 2 and 3 with neoprene pads and end grinding with neoprene pads. Type 2 and 3 break patterns were observed with sulphur preparation and end grinding with bearing plates during testing.

Table 2. Effects on the mean compressive strength and the type of break observed

Neoprene Pads Test method	Compressive strength (psi) 30 samples Average	Percentage from test on fracture Pattern Type 1	Percentage from test on fracture Pattern Type 2	Percentage from test on fracture Pattern Type 3
Value	4204	NA	80%	20%
Sulphur Test Method	Compressive strength (psi) 30 samples Average	Percentage from test on fracture Pattern Type 1	Percentage from test on fracture Pattern Type 2	Percentage from the true of fracture 3
Value	4194	3%	53%	43%
Grinding (bearing Plates) Test method	Compressive strength (psi) 30 samples Average	Percentage from test on fracture Pattern Type 1	Percentage from test on fracture Pattern Type 2	Percentage from test on fracture Pattern Type 3
Value	4203	NA	43%	57%
Grinding (Neoprene pads) Test Method	Compressive strength (psi) 30 samples Average	Percentage from test on fracture Pattern Type 1	Percentage from test on fracture Pattern Type 2	Percentage from test on fracture Pattern Type 3
Value	4232	3%	73%	20%

Effects on the Coefficient of Variation (COV)

The COV as presented in Figure 2 is the ratio of the standard deviation and its mean compressive strength. COV is normally used to assess the overall dispersion of test results. It is noted that:

- Neoprene Pads Test method has the lowest and a satisfactory COV value of 2.59%
- Sulphur Test Method has an unsatisfactory COV value of 3.43%
- The end grinding method with bearing plates has a satisfactory COV value of 2.73%
- The end grinding tested on neoprene pads has a satisfactory COV value of 2.64%

All COV value preparation methods are lower than the COV of 3.2%, given in ASTM C39 for a 4x8 inch standard cylinder with the exception of the Sulphur Preparation Method. This means the concrete cylinders used in this investigation have constant and high quality in terms of compaction, curing, capping & grinding and crushing. The very high COV of 3.43% for the case of sulphur preparation removes the possibility of utilizing of the sulphur preparation method for this design strength in this study.

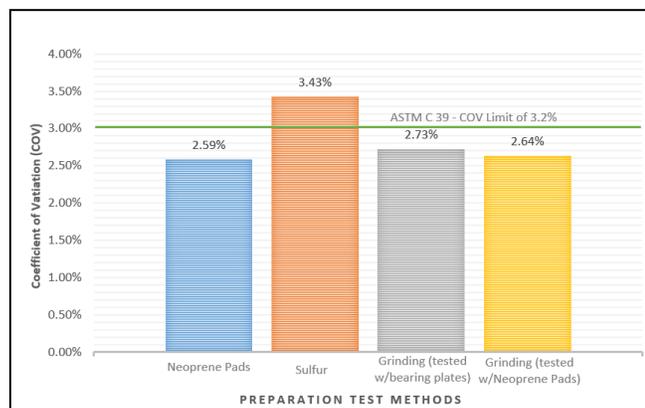


Figure 2. Effects on the COV

Conclusions and Recommendations

- Concrete cylinders with end grinding preparation and testing on the bearing plates gave the compressive strength values quite consistent with the concrete cylinders tested on Neoprene pads. Concrete cylinders tested with the preparation of end grinding with neoprene pads achieved relatively higher compressive strength which showed very consistent results. Sulphur preparation produced the lowest compressive strength results.
- The dispersion, in terms of Coefficient of Variation (COV), was significantly affected by the Sulphur preparation. The end grinding with bearing plates and the end grinding with neoprene pads had satisfactory COV values of 2.73% and 2.64%. The neoprene pads with no end preparation having the lowest COV of 2.59%.
- The Nebraska Department of Transportation is currently using the two preparation methods, which averaged the lowest ranking values, the neoprene pads with no end preparation and end grinding preparation with neoprene pads. However, since the neoprene pads with no end preparation provide the lowest COV, the Department will begin using neoprene pads for the compressive testing without any further end preparations. This includes all the district labs and central lab.

References

1. ASTM C39/C39-M – 17a, “Standard test method for compressive strength of cylindrical concrete specimens”, Annual Book of ASTM Standards, Vol 04.02.
2. Dumitru, I., Song, T., Caprar, V., Mukhin, V., “Compressive Strength of Concrete Cylinders by Sulphur, Rubber Capping and Grinding Methods”, Boral Construction Materials (NSW/ACT).