

Strength, Unit Weight and Elasticity of Concrete Cylinders from Benicia-Martinez Bridge

RESULTS: In testing 1027 cylinders, it was confirmed that the strength of lightweight concrete performed closely to what was expected and predicted. The confidence and performance of using lightweight concrete on the Benicia-Martinez is validated.

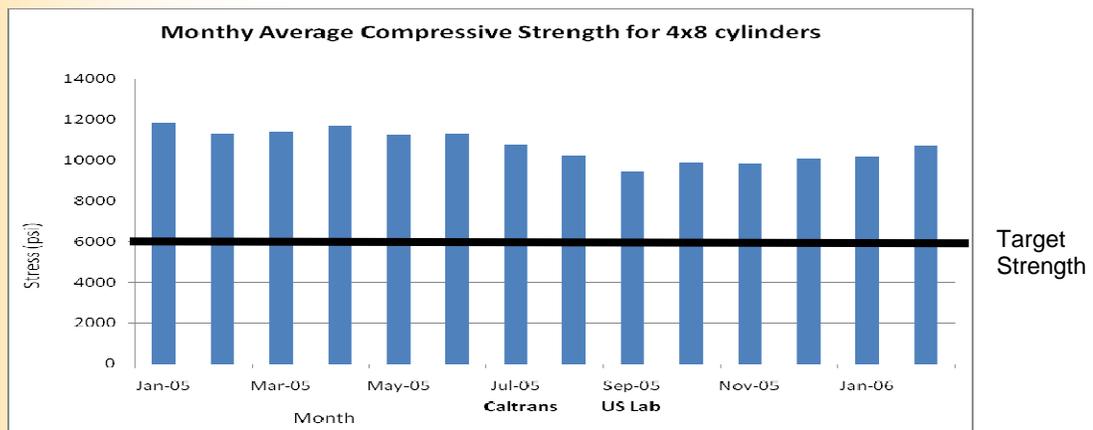
Background

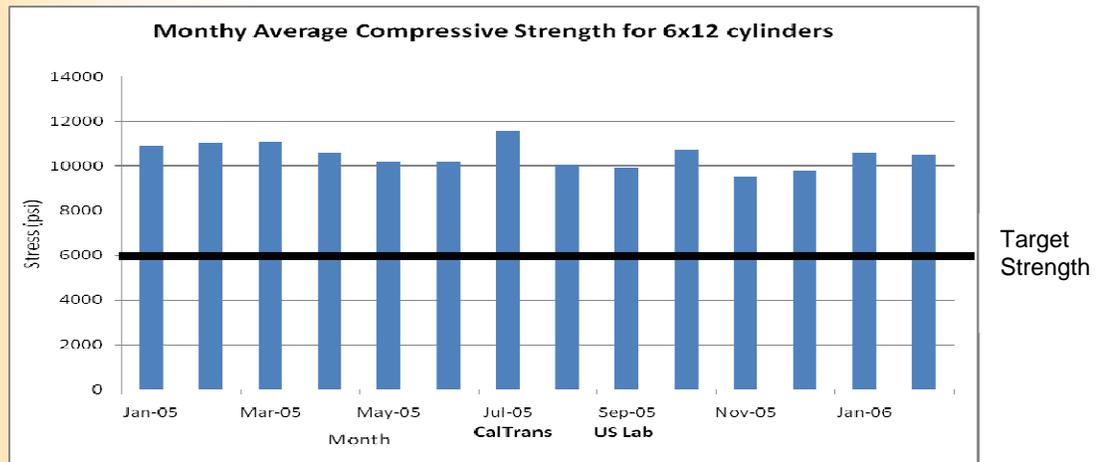
In 2005, lightweight aggregate concrete was placed on the Benicia-Martinez Bridge during construction. The purpose of using lightweight aggregate concrete instead of regular weight concrete is to keep the bridge weight low so it can carry the required capacity. Concrete cylinders were collected during construction and sent to San Jose State University to determine the compressive strength, modulus of elasticity and density over 5 years.



Why We Pursued This Research

Lightweight aggregate was used in the concrete of the Benicia-Martinez Bridge. Lightweight concrete is less dense than normal weight concrete and therefore, weighs less. Although concrete was tested at the age of 35 days to determine its strength, it was necessary to validate the long term compressive strength, modulus of elasticity and density of the concrete on this bridge to determine the long term performance. Both 4x8 inch and 6x12 inch concrete cylinder samples were collected during construction. This study seeks to determine if the smaller 4x8 in. cylinders can be utilized as an alternative to the 6x12 in. cylinders.





What We Did

Office of Earthquake Engineering from Engineering Service Center contracted with San Jose State University to test lightweight aggregate concrete cylinders collected during Benicia-Martinez Bridge construction. Specimens were transported to San Jose State University and tested at the age of 5 years. The results were statistically analyzed to compare it with the results obtained at 35 days. The test included comparing 4x8 in. and 6x12 in. cylinder sizes on compressive strength.

Research Results

The compressive strength of the Benicia-Martinez Bridge concrete has good long-term performance. The statistical analysis showed that the bridge will never fall below its target compressive strength during its lifetime.

The following other conclusions are also drawn from the results:

- The average compressive strength increased by 3.6% at the age of 5 years from those observed at 35 days.
- The average compressive strength of the 4x8 in. cylinders was 2% more than the 6x12 in. cylinders at 5 years.
- At 5 years, the maximum strength has increased by 9% and the minimum strength has increased by 6.6% for the 4x8 in. cylinders when compared to those at 35 days.
- The production test average was 10,500 psi (72 MPa) at the age of 35 days and it has not dropped in 5 years.
- The probability of any single strength falling below the minimum observed strength decreased at 5 years.
- The probability of falling below the target compressive strength essentially approached zero at 5 years.
- The modulus of elasticity computed from the 6x12 in. cylinder was 3.79×10^5 ksi (2.6 MPa) at 5 years.
- The concrete has maintained its dry density of 125 lb/ft³ (2,002 kg/m³) at 5 years.

Recommendations

From the study, it is observed that there is no significant difference between the compressive strengths determined from 4x8 in. and 6x12 in. cylinders at 5 years. Therefore, testing can be performed on 4x8 in. as an alternative to 6x12 in. Using smaller concrete cylinders to test for long-term compressive strength will save material and be easier to handle and transport during construction.

Reference

Akthem Al-Manaseer, Saad Nadeem, Ric Maggenti, Peter Lee: "Strength Unit Weight and Elasticity of Concrete Cylinders for the Benicia Martinez Bridge", Final Report, March 2011, 55 pp.

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