



**CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY**

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Project Title
Torsional Fracture Strength Tests of Sulfur Concrete

Abstract

Objectives/Goals
When sulfur is mixed with sand, heated to melting, and cooled it forms sulfur concrete. Sulfur concrete is becoming widely used industrially because of its attractive characteristics including good resistance to chemical attack and fatigue compared to Portland cement based concrete. The question to be answered in the study was: How does changing the sand-sulfur ratio, concrete temperature, and quench rate affect the strength of sulfur concrete?

Methods/Materials
The test coupons were made by pouring a mixture of sulfur and sand into metal containers. A bolt and washer were inserted into the mixture. The samples were then set in an oven for one hour at 450F. Once melted, the concrete was cooled for one hour. The samples were then clamped down and torqued with a torque wrench to determine the torsional fracture strength. For the sand-sulfur ratio test, various ratios of sand and sulfur were examined. For the temperature test, the samples were stored and torqued at different temperatures. For the quench test, the samples were quenched and held in an ice bath at different time increments.

Results
The key findings were:
-The fracture strength increased as the sulfur content increased, up to a sulfur content of forty percent. Beyond this value, the strength did not increase with increasing sulfur.
-Sulfur concrete strength varies little from -108F to 175F, but declines rapidly at 200F and above.
-As the time in the ice bath increases, the strength of sulfur concrete slowly increases until after about one day when it reached its maximum strength.

Conclusions/Discussion
-I found the maximum practical temperature of sulfur concrete is no higher than 200F which is well below sulfur's melting point of 248F.
-It took about one day to reach sulfur concrete's maximum strength in an ice bath likely because quenching the sample in an ice bath forms a plastic, amorphous sulfur state, which slowly converts to the harder crystalline state.

Summary Statement
How does changing the sand-sulfur ratio, concrete temperature, and quench rate affect the strength of sulfur concrete?

Help Received
Dad helped find a torque wrench. Mom helped take the molten sulfur out of the oven. Dad helped place the molten sulfur into the ice bath. Dad helped purchase the dry ice. Mom helped format the display board. Dad helped in editing the papers.