



EMPOWER | INNOVATION | CHAMPIONS 2014 INNOVATION FAIR

DIVISION OF DESIGN

GREEN CONCRETE ON THE SFOBB

- ▶ About 7% of greenhouse gas worldwide & about 2% in USA comes from the manufacture of cement.
- ▶ Rule of thumb: 1 ton of Portland cement results in 1 ton of CO₂ (greenhouse gas)
- ▶ So reducing the amount of Portland cement in concrete will directly reduce CO₂.
- ▶ Supplementary Cementitious Materials (SCM) can be used to reduce the amount of Portland cement.

- ▶ Flyash and slag are used as SCMs. They are also waste products which are being reused, so we have the double benefit of recycling plus greenhouse gas reduction!
- ▶ SFOBB design team's drive to use SCMs were based on improvements to workability, durability, strength and cost reduction. Resulting "green" benefits were secondary advantages.



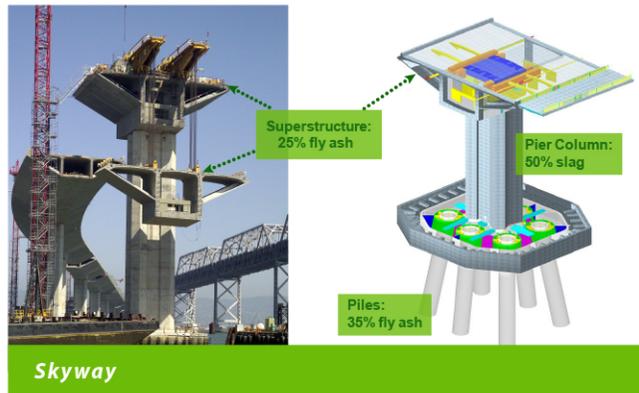
YBITS



YBITS



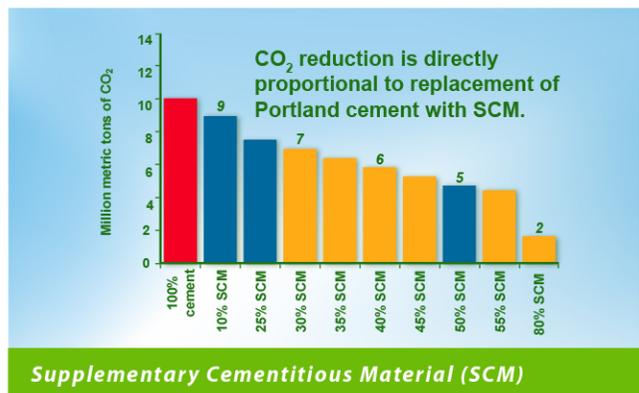
SAS (Self-Anchored Suspension)



Skyway



Oakland Touchdown



Supplementary Cementitious Material (SCM)



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DIVISION OF DESIGN

Deputy District Director: Helena "Lenka" Culik-Caro

Number of Division Employees: 314

Contact Person: Ric Maggenti

GREEN CONCRETE ON THE SFOBB

Overview of the Office of Toll Bridge Design

This Office is very similar to other Design Offices and, until recently, focused primarily on toll bridge retrofit and/or replacement projects. One aspect of this Office that is unique is that it also comprises structure engineers, structure specification writers, and a structure cost estimator. This Office is responsible for: preparation of Project Reports; preparation of PS&E and/or oversight of consultant prepared PS&E; coordination with FHWA and local/permitting agencies; determine right of way needs for projects; support Construction during the construction phase of the project; processing design fact sheets; district utility engineering; preparation of cost estimates on a quarterly basis for the Toll Bridge Seismic Retrofit Program Reports for the California Legislature.

Quick facts about greenhouse gases as they relate to concrete:

- ▶ Main type of greenhouse gas is CO₂.
- ▶ More than 90% of greenhouse gases stem from fossil fuel combustion.
- ▶ About 7% of greenhouse gas worldwide & about 2% in USA comes from the manufacture of cement.
- ▶ Rule of thumb: 1 ton of Portland cement results in 1 ton of CO₂
- ▶ So reducing the amount of Portland cement in concrete will directly reduce CO₂. Supplementary Cementitious Materials (SCM) can be used to reduce the amount of Portland cement.

SCMs are used to reduce the amount of portland cement in concrete:

Portland cement can be partially replaced by Supplementary Cementitious Materials (SCM). Some examples of SCMs are: flyash, blast furnace slag, silica fume, and natural pozzolans. SCMs are primarily used for improved workability, durability and strength. They offset some of the undesirable effects (like thermal cracking) of Portland cement. Flyash is a byproduct of coal-fired furnaces at power plants. Slag is a byproduct of blast furnaces used for iron production. Silica is a byproduct of silicon metal production. Natural pozzolans are derived from volcanic regions – in fact, the word "pozzolan" comes from the town of Pozzuoli, near Mt. Vesuvius, where volcanic ash was used to make concrete by the Romans.



Flyash: a byproduct of coal



The Colosseum, Rome



So what makes the use of SCM “green”?:

- ▶ Greenhouse gas production is reduced by using SCMs in place of cement (remember, 1 ton of cement = 1 ton of CO₂)
- ▶ flyash and slag are waste products which are being reused in concrete => recycling!

We have to confess, “green concrete” was not the initial intent, but rather, a welcomed benefit

Caltrans used SCMs because of the long-term strength benefits they provide: reduced heat rate of cement reaction, increased durability, and less cost than cement. Before 1995 Caltrans sometimes used 15% flyash for durability, usually dictated by the aggregate. After 1997 25% flyash was used in almost all structural concrete. But on the SFOBB (Bay Bridge), we outdid ourselves and used:

35% IN THE LARGE PILES (MORE WAS ALLOWED)



35% - 50% IN THE ALL MASSIVE FOOTINGS



50% SLAG IN THE PIER COLUMNS FOR SKYWAY



50% SCM (20% FLYASH & 30% SLAG) ON YBI.

