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The Road to Shambala

INTRODUCTION

Pervious concrete utopia (Shambala) is where low cost pervious PCC mixtures requiring low compaction have good permeability and an average core compressive strength of 4000-psi at 28-days. In Shambala, the interstates are overlayed with pervious PCC improving skid resistance, reducing truck spray and noise and virtually eliminating hydroplaning. Finding Shambala, although not as good as finding Eldorado, would be a true cause to celebrate and a joy to the world, the concrete world that is. Shambala lies at the corner of the Right Amount of Paste Avenue and Good Aggregate Street. I recently got a tip on how to find Good Aggregate Street, I would rather not reveal my source; let's just say I heard it through the grapevine. The tip stated that ASTM C 29 dry-rodded-unit-weight (DRUW) voids were the key to finding Good Aggregate Street. In the showdown between concrete and asphalt, we can leave no stone unturned. Since I can't get it out of my head, I decided to investigate.

MATERIALS AND MIXTURES

All mixtures in this very preliminary investigation contained 480-lbs/CY of Type I PC, 120-lbs/CY of Class F fly ash, and 180-lbs/CY of water. Each mixture also contained small doses of the following chemical admixtures: mid-range water reducer; hydration stabilizer; and a viscosity modifier. All mixtures were designed with twenty percent nominal air voids. Each mixture contained sufficient aggregates to attain a design volume of twenty-seven cubic feet. Aggregates were selected to produce a range of DRUW voids. The project was not funded and aggregate selection was also based on availability. Fortunately, several aggregates were donated by members of the concrete industry.

PROCEDURE

The DRUW voids of each aggregate combination were determined as per ASTM C 29. All pervious PCC batches were 0.6-cubic feet in size. Each batch was mixed in a one-cubic foot capacity electric shear mixer. One ASTM C 1688 plastic unit weight test was performed and one 6x6x24-inch beam was cast from each batch. All beams were cast in one layer in reusable wood molds. Each beam was compacted with two passes of a 6x12-inch concrete rolling pin. Following casting, each beam was covered with plastic and allowed to cure for approximately 24 hours. The next day, the beams were de-molded and placed in a lime-water immersion tank. The beams were cored at seven to ten days. Four cores were cut from each beam. Two of the cores were used for compressive strength and two were used to determine ASTM D 7063 hardened effective void content. The two cores used for

ASTM D 7063 hardened effective void determination were dried at 230°F for seven days. Compressive strength was determined at 28 days using the other pair of cores.

RESULTS

Results are shown in Table 1.

ANALYSIS OF PRELIMINARY RESULTS

The ASTM C 29 DRUW voids of the aggregate are primarily a measure of aggregate gradation but are also influenced to a lesser degree by aggregate angularity and surface texture. DRUW voids increase with increasing gradation uniformity, increasing angularity and rougher surface texture of the aggregate. Aggregate DRUW voids can be manipulated by blending fine aggregate with the selected coarse aggregate.

The authors attempted to determine if the DRUW voids of the selected aggregate combination affected the plastic and hardened voids and compressive strength of pervious PCC. Figure 1 shows a promising relationship between aggregate DRUW voids and ASTM C 1688 plastic voids. No relationship was found between aggregate DRUW voids and ASTM D 7063 hardened PCC voids. Figure 2 shows a promising relationship between aggregate DRUW voids and pervious PCC core compressive strength.

OBSERVATIONS

1. Seven data points is not enough to draw conclusions. More data is needed.
2. Aggregate DRUW voids may be helpful in selecting aggregates for pervious PCC.
3. Aggregate DRUW voids can easily be decreased using fine aggregate blending.
4. Shambala is just over the next hill. I saw it briefly.
5. If you found seven different song titles in the first paragraph, you have heard music from the early 1970s (I did not say or even imply that you were old).

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TABLE 1. PRELIMINARY RESULTS

Aggregate Combination	ASTM C 29 Voids (%)	ASTM C 1688 Plastic Voids (%)	ASTM D 7063 Effective Voids (%)	Average Core Comp Strength (psi)
No. 89	37.9	7.9	18.1	4400
No. 89 + 4% MS	37.4	8.6	23.2	3740
No. 8	43.1	15.0	27.8	1990
No. 8 + 4% RS	41.7	15.3	26.5	2420
No. 8 + 8% RS	40.3	14.9	28.6	2660
No. 7	40.9	15.3	22.8	2660
No. 7 + 7.5% RS	38.2	10.4	21.9	3420

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3. Figure 1 ASTM C 1688 Plastic PCC Voids vs. ASTM C 29 DRUW Aggregate Voids.
4. Figure 2 Average PCC Core Compressive Strength vs. ASTM C 29 DRUW Aggregate Voids. ♦

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