2004 TCA Pervious PCC Research at TTU: 5 Questions

By L. K. Crouch, Nathan Smith, Adam Walker, and Tim Dunn

Background

In early 2004, TCA sponsored an evaluation of pervious PCC permeability at TTU. At the conclusion of the initial phase of the evaluation in August 2004, TCA agreed to sponsor a continuation of the investigation to further characterize and possibly improve pervious PCC. The following five questions explore the progress to date.

Question 1: What Permeability Values Can Be Expected From Pervious PCC?

Permeability values are a function of effective void content and aggregate gradation / type are shown in figure 1. Blank spaces in the grid floor indicate that pervious PCC containing that aggregate could not be produced or tested at that effective void content. Reference permeability values for various unbound aggregates are provided in Table 1.

Table 1. Reference Permeability Values

Material	Permeability Range* (cm/sec)
Clean sands, clean sand & gravel mixtures	0.001 to 1.0
Clean gravel	1.0 to 100
Rip rap	100+

* - actual value dependent on gradation, shape, and density

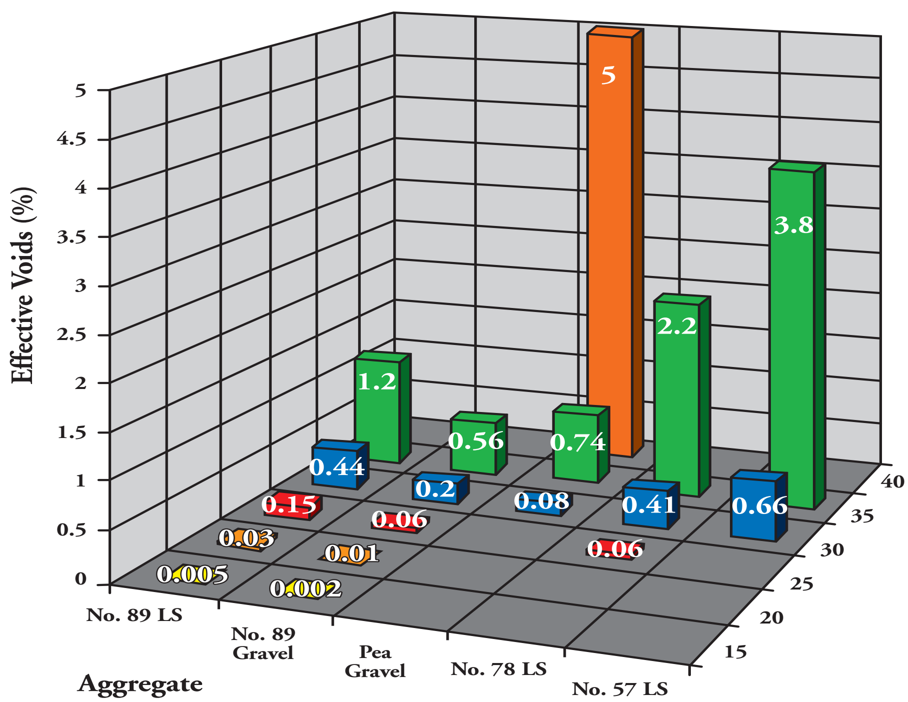

Figure 1. Laboratory Pervious PCC Permeabilities for Various Aggregates at Different Effective Void Contents

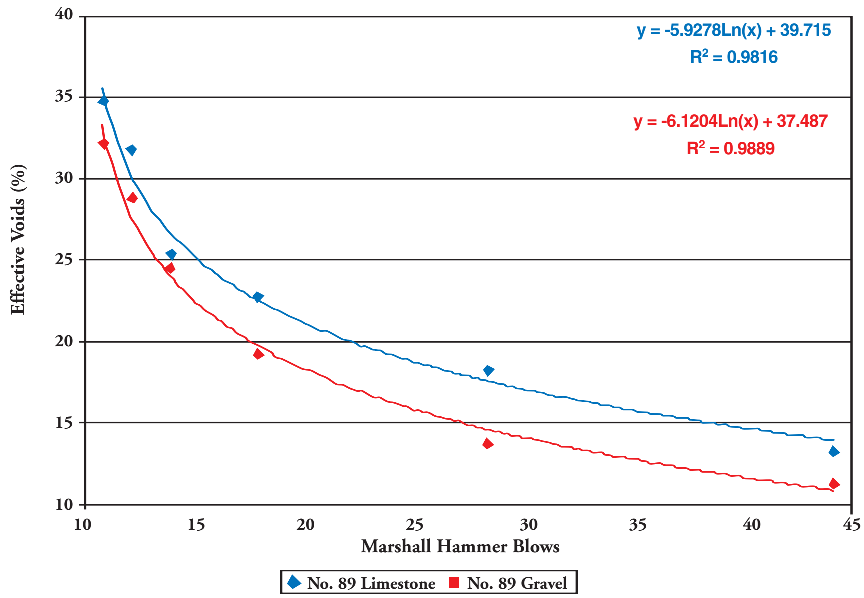

Figure 2. The Effect of Compactive Effort on Pervious PCC Effective Voids

Question 2: How Are Different Effective Void Contents Achieved?

Effective void content is a function of aggregate properties (gradation, shape, and texture), paste amount and compaction. A Marshall Hammer is used to compact pervious PCC into a 4 x 8-inch steel mold in the laboratory. Figure 2 shows the effect of compaction on effective voids. Field compaction is provided by a structural steel tube roller filled with water and / or sand pulled by hand (see figure 3) or less commonly by a high-density paver.

Current pervious PCC mixtures are harsh (no sand, low w/c). Harsh mixtures are more difficult to unload, place, and compact. If pervious PCC could be unloaded, placed and compacted more easily yet maintain adequate permeability and compressive strength in-service, the popularity and use of pervious PCC would increase. The authors and a TCA-member admixture producer (with guidance from TCA Executive Director Alan Sparkman) are currently attempting to answer this question.

Some ideas for reducing unloading / placing / compaction difficulty are:

1. Substitution of gravel for crushed stone as aggregate. Figure 2 clearly indicates that pervious PCC containing gravel aggregate compacts easier than pervious PCC with crushed stone aggregate. The smoother shape and texture of gravel gave rise to concerns about reduced compressive strength. Figure 4 indicates that this should not be a problem.

2. Partial replacement of the PC with fly ash – an idea borrowed from Dr. Heather Brown who demonstrated the PH and cost benefits of fly ash in pervious PCC.

3. Use chemical admixtures to produce a more fluid paste. However, the paste which lubricates the aggregates for easier compaction must not drain down or seal the surface.

4. Gradation alterations – still in the conceptual phase.

Question 5: When Will More Information Be Available?

The authors hope to make a presentation at the TCA Convention in February 2005 and submit technical articles for publication later in 2005.

Acknowledgements

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Question 3: Is Lab Pervious PCC similar to Field Pervious PCC?

Yes, very similar (see Figure 3). Laboratory compressive strengths are typically a little higher due to better curing and more consistent compaction. Laboratory pervious PCC with almost any desired effective void content can be produced to model field pervious PCC behavior.

Question 4: Can Pervious PCC Retain Adequate Permeability and Compressive Strength and Become Easier to Unload, Place and Compact?

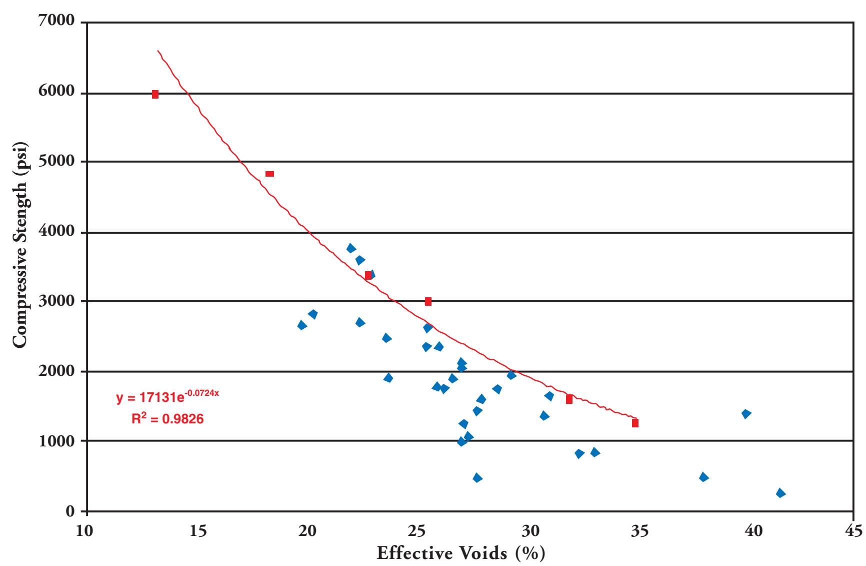

Figure 3. Compressive Strength versus Effective Voids

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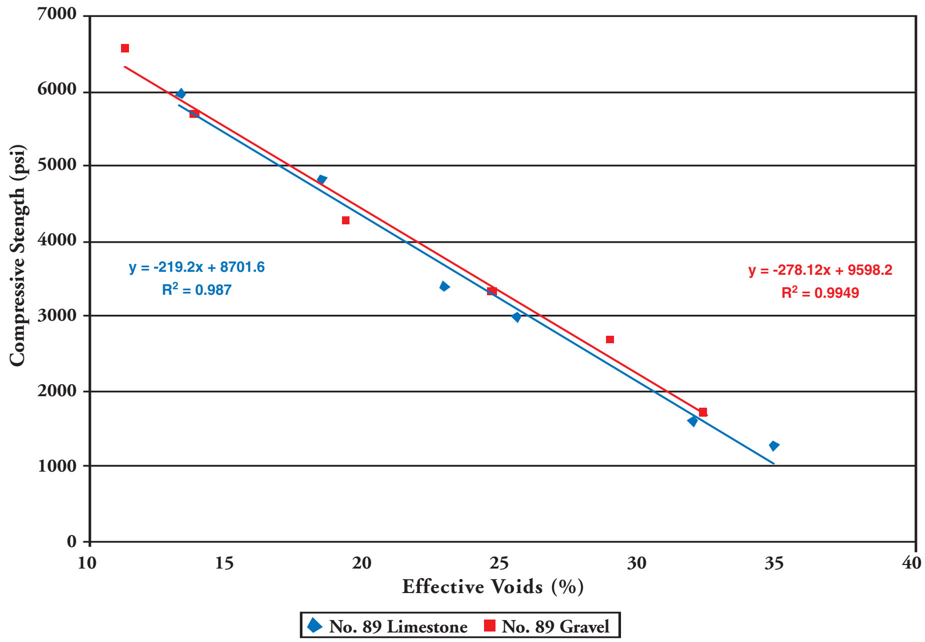

Figure 4. Comparison of No. 89 Limestone & No. 89 Gravel Pervious PC Compressive Strengths