DRISI

Caltrans Division of Research,
Innovation and System Information

Research Results

# Using Recycled Materials in Roadway Foundations

Better understanding of the properties of recycled materials helps achieve more cost-effective use of resources

Pavement

**NOVEMBER 2014**

**Project Title:**
Recycled Unbound Pavement Materials (MnROAD Study), TPF-5(129)

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## WHAT IS THE NEED?

The pavement layer of a road is supported by layers of aggregate materials consisting of gravel, crushed rock, and sand. With these materials being depleted in the United States, it is becoming increasingly com mon to recycle pavement that has reached the end of its service life. Most state departments of transportation (DOT) allow using recycled materials, such as reclaimed asphalt pavement (RAP) and recycled concrete aggregate (RCA), in road foundations, and current design procedures assume that recycled materials have similar properties to those of typical virgin aggregates. However, it is not well understood how the properties of recycled materials, including strength, stiff ness, and sensitivity to climate, affect pavement performance. In addition, the use of crushed concrete has raised some environmental concerns in terms of potentially leaching hazardous contaminants to the ground. This pooled-fund study was initiated to understand the properties of recycled unbound pavement materials to better predict performance and ensure that the materials are environmentally safe.

## WHAT WAS OUR GOAL?

The goal was to assess how the properties of recycled materials used in aggregate base layers of roadways affect pavement performance and the environment.

## WHAT DID WE DO?

Caltrans, as part of this pooled fund study with the Michigan, Minnesota, Ohio, Texas, and Wisconsin DOTs, supported the lab and field test programs. The research team at the University of Wisconsin at Madison con ducted lab tests on both RAP and RCA samples from eight geographically diverse states and monitored newly constructed field test sections at a Minnesota

DOT facility. A conventional Class 5 gravel base course was used as a control. The researchers investigated the following properties:

- Grain size distribution, fines content, asphalt content (RAP only), mortar content (RCA only), specific gravity, absorption, and impurities
- Proctor test compaction characteristics, plastic deformation, resilient modulus, and the effects of varying compaction and freeze-thaw cycling on resilient modulus
- Hydraulic properties, and for RCA, pH and metal leaching character istics
- Mechanical properties under different climatic conditions as well as the effect of wet-dry cycling on particle degradation
- Deflection of various aggregate base course materials from 2009–13 via falling weight deflectometer tests, from which moduli were back-calculated

## WHAT WAS THE OUTCOME?

RAP and RCA pass all necessary standards for being a suitable base course material. They are structurally and mechanically comparable, if not superior, to many natural aggregates. The RAP and RCA resilient moduli are higher than the natural aggregates used as a control material. Brick content of up to 30% in RCA did not affect resilient modulus. All materials have high drainage capacities, with RAP having the highest, followed by natural aggregate and RCA. The hydraulic properties are similar or superior to that of natural aggregate, and they similarly withstand the extreme effects of climate. However, some RAP might be sensitive to temperature change, potentially leading to rutting. Leachate slightly exceeded Environmental Protection Agency drinking water maximum contaminant levels on only a few occasions for all materials—these measure ments are for the base layer; metal levels would be expected to fall before reaching groundwater.

## WHAT IS THE BENEFIT?

As nonrenewable resources become more scarce, it is increasingly important to investigate the use of recycled materials in pavement design. This study produced extensive data on the properties of recycled paving materials and how they affect performance when used in unbound aggregate base layers. It also addressed environmental concerns to mitigate the possible ill effects of effluent from recycled concrete. Engineers can use the data to broaden the application of mechanistic-empirical pavement design methods to more accurately predict pavement performance and optimize resources.

## LEARN MORE

To view the complete report and other information regarding this pooled fund study:
www.pooledfund.org/Details/Study/361

## IMAGES

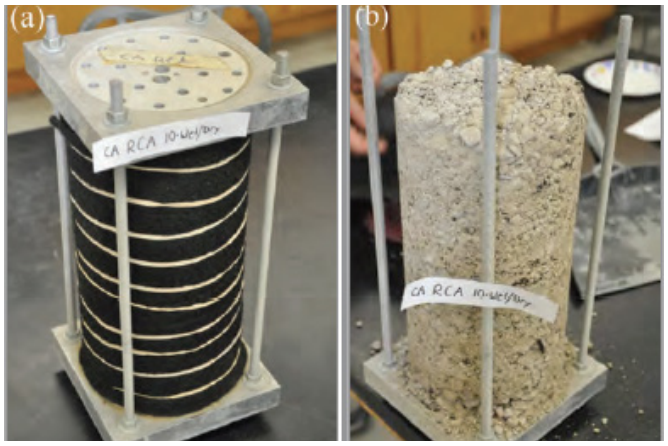

Figure 1: California RCS lab test samples


Figure 2: Stockpiles of recycled pavement materials