

EFFECT OF RECYCLED SUBBASE AGGREGATES ON PIPE UNDERDRAINS

For decades the Ohio Department of Transportation has used by-product aggregates such as iron and steel slag, slacker aggregate, and steam-boiler slag for highway subbase courses. These aggregates are cost-competitive with natural aggregates in areas near their production sources. The department recently used recycled concrete pavement as subbase on two projects and in-place rubblized concrete pavement as subbase on several others. The use of these by-product aggregates does pose some risk. Steel slags, slacker aggregate, recycled concrete, and rubblized concrete pavement have been identified as sources of tufa precipitate, which builds up in pipe underdrains and storm sewer systems on highway projects. Tufa is a porous calcium carbonate deposit that forms as water drains through aggregate containing free lime.

The problem of precipitate formulation was first identified in 1977 during field data collection for a research project performed by Kent State University on erosion and sloughing of highway slopes in northeastern Ohio. The tufa build-up at underdrain outlets, sewer outlets, and on slopes was attributed to pavement water leaching through carbonate base course. However, the specific type of aggregate involved was not determined. Further research undertaken in 1980 by the university identified slag and slacker aggregate as the aggregates involved and detailed the chemical reaction of the precipitate formation. Differentiation among the different types of slag still was not made.

Ohio DOT personnel, in evaluating the usefulness of flushing and repairing existing underdrains, established the seriousness of the precipitate problem. Underdrain systems had been rendered nearly useless by deposits that plugged pipes and by the cementing of the sand or slag backfill in underdrain trenches. The department therefore prohibited the use of slag and slacker aggregate for subbase material and specified exclusive use of natural pea gravel (American Association of State Highway and Transportation Officials No. 8 aggregate) for backfill for underdrain trenches.

Research conducted in the mid-1980s by ODOT determined that steel slags and slacker aggregate were sources of tufa because of their high free-lime (CaO) content. Iron slags (air-cooled blast-furnace slag and granulated slag) were not potential sources of tufa because they lack free lime. Basic oxygen slag had a much greater potential for precipitate formation than open-hearth slag, which has less initial free lime and in most cases has been stockpiled for decades. As a result, iron slags were again permitted as subbase aggregate and underdrain backfill. Basic oxygen slag was still prohibited, and limited use of open-hearth slag was allowed on the basis of past performance of open-hearth from specific stockpile sites.

Observation of the projects in which recycled concrete and rubblized concrete pavements had been used as subbase material indicated that these aggregates also have some potential for causing precipitate formation. Based on these observations, the Ohio DOT does not permit the use of recycled concrete as subbase and has limited the use of rubblized in-place concrete pavement as subbase.

Researchers at Toledo University recently developed testing procedures to quantify free-lime content of steel slag and recycled concrete aggregates. Using these tests and previous site performance, ODOT hopes to identify specific sources of these aggregates for which indications of precipitate potential are minimal. Aggregates from those sources may then be used as subbase material. Further research has been proposed to identify measures of economically reducing this precipitate potential. It is hoped that the results of this work will lead to a solution that allows broader use of these waste aggregates without compromising drainage systems.

—John O. Hurd
Ohio Department of Transportation