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A Review of Roadway Water Movement for Beneficial Use of Recycled Materials

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Abstract The purpose of this chapter is to provide a comprehensive review of water movement in roadways so that this knowledge may be used in environmental impact studies of traditional and recycled pavement materials. Long term leaching of contaminants is dictated in part by the hydrology of the roadway environment. To determine the hydraulic regimes in the field, ingress and egress routes and the hydraulic conductivity of the materials need to be known. This paper demonstrates that the major water ingress routes are along cracks, joints, and shoulders. It is shown that both saturated and unsaturated conditions in the field occur, suggesting that the contaminant leaching studies that consider saturated conditions

only may overlook the effects of unsaturated conditions and the effects of wetting and drying. Furthermore, moisture content and unsaturated conditions have significant spatial and temporal variations in pavement systems. The hydraulic conductivity of pavement materials presented in the literature vary significantly due to various pavement designs, however, the hydraulic conductivity of pavement is less significant in influencing pavement system hydraulic regime than are cracks, joints, shoulders, and drainage systems.

Keywords Recycled materials · Pavement · Hydraulic conductivity · Leaching · Unsaturated flow

List of Abbreviations and Symbols

ACOE	The United States Army Corps of Engineers
FHWA	Federal Highway Administration
L/S	Liquid to solid ratio
MSW	Municipal solid waste
PCC	Portland cement concrete

1 Introduction

1.1 Recycled Materials Use in Roadways

There are nearly 6 million kilometers of roads in the United States (US) [1]. Construction and maintenance of these roadways require use of large volumes of materials. Numerous by-product and waste materials, produced in millions of metric tons per year, have the potential to be recycled in roadway applications (Table 1). The US Highway agencies have been using recycled materials with varying degrees of success for the past 20 years. At least 22 states have approved the use of coal fly ash and coal bottom ash in road construction [5]. The US also has a history of use of recycled asphalt pavement, reclaimed concrete pavement, blast furnace slag, and scrap tires. Theoretically, annual demand for construction materials (350 M tons) is close to the supply (353–859 M tons) of waste materials that have the potential to be recycled in roadway applications [6, 7]. However, the US is far from fully utilizing its recycling potential. Compared with many European countries, there is less than optimum recycling in the roadway environment. For example, reclaimed asphalt pavement, blast furnace slag, coal bottom ash, coal fly ash, and municipal solid waste (MSW) ash are completely recycled in the Netherlands and only partially or not at all recycled in the US [8].

1.2 Incentives for Studying Water Movement in Pavements

Water movement in pavements has traditionally been studied by pavement engineers to understand the relationship between moisture in the pavement and