

CRITERIA FOR DESIGNING LIGHTWEIGHT CONCRETE BRIDGES

Research, Development,
and Technology

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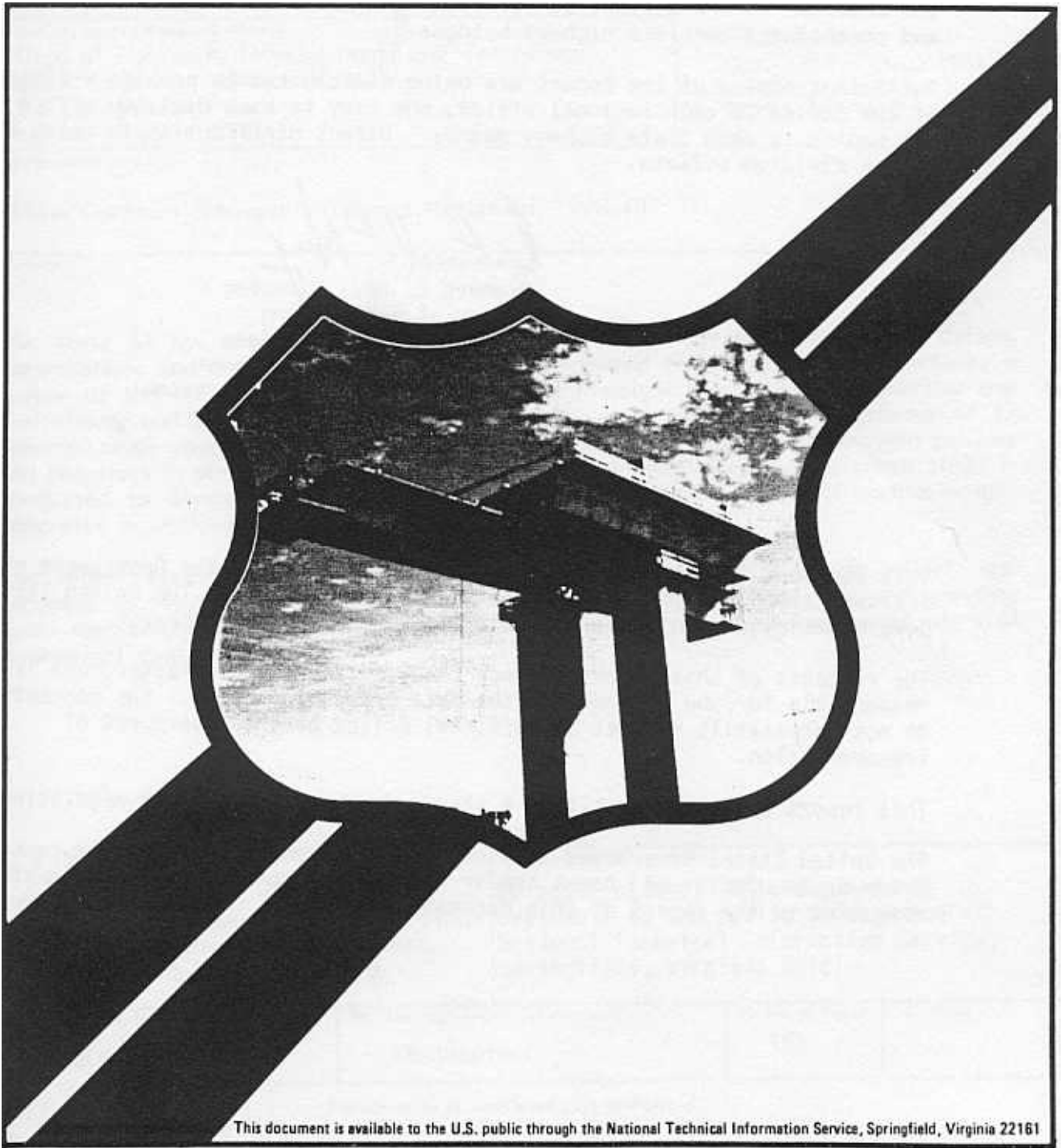


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INTRODUCTION

This report has been prepared for the Federal Highway Administration (FHWA), to study the state of the art of lightweight concrete in application to structures, particularly bridge structures. Its main purpose is to investigate the performance and potential of lightweight concrete for bridge use. Although not intended to be a manual of practice, it should provide the bridge designers with useful information on past experience when considering the possible use of lightweight concrete in their structures.

Lightweight concrete is concrete containing lightweight aggregates, coarse or fine or both, which make it lighter in weight than concrete made with normal-weight coarse aggregates and sand. Lightweight aggregates are generally classified as naturally occurring materials, industrial byproducts, and expanded shales, clays, and slates. Naturally occurring aggregates come mainly from volcanic deposits, such as pumice or scoria. Industrial byproducts include such materials as expanded blast-furnace slag or sintered fly ash. Expanded shale, clay, and slate aggregates are formed by expanding or bloating the materials with heat. The latter type of aggregates are commonly used in structural concrete, and are therefore of prime interest in bridge design and construction. A summary of the present state of the technology is given in ACI 213 report "Guide for Structural Lightweight Aggregate Concrete."(1)*

The main attraction of structural lightweight concrete is its lower unit weight, which is about 115 pcf (1,760 kg/m³). It is therefore mostly used in structures where weight reduction is an important economic or design consideration.

*Numbers denote references listed at the end of the report.

The first extensive use of structural lightweight concrete was in the building of ships during World War I. Its use soon spread to buildings, and then to bridges. On a volume basis, lightweight aggregates are at present mostly used in the production of concrete masonry blocks for buildings. Other uses in the building industry include lightweight structural members, both cast-in-place and precast. The lighter concrete weight is especially advantageous for the transportation and erection of precast concrete members.

Lightweight concrete has become established in the building construction industry. Building designers and contractors are familiar with the material, and have routinely used it where it is economically or functionally justified.

The acceptance of lightweight concrete in the construction of bridges has been slower than in buildings. So far, it has mainly been used in roadway decks over steel girders. Only occasionally is it used in the primary structural members of a bridge.

The performance of the lightweight concrete in bridges has generally been satisfactory, but there have been problems. Most of the problems have to do with the specifications of the concrete, its placement in the field, and the familiarity with its behavior. There have also been conflicting opinions regarding the occasional poor performance of the material.

Although there is no consensus of opinion concerning the suitability of lightweight concrete for bridge structures, nor concerning experiences with its performance, it should be noted that the material does have sufficient record of successful applications to make it a suitable construction material for buildings and ships, as well as for bridges.

Sufficient information is available on all aspects of its performance for design and construction purposes. Much of this report is in fact based upon available publications, a selected list of which is given in the references. Other important reference publications are presented in the bibliography.

To be useful this report must provide information concerning the state of the art and experiences with the use of lightweight concrete in bridges. For this reason considerable effort has been made to collect relevant data from past users, the industry, and institutions. The data-collection program included the following:

- A search for pertinent literature.

Inquiries through personal contact with key individuals in the industry and institutions, together with a survey of United States and Canadian rotary-kiln producers of expanded shale, clay, or slate aggregate.

- Survey of bridge engineers from 23 States.
- Invitation to four selected State bridge departments to report on their experiences in the use of lightweight concrete.
- Visits to lightweight-aggregate manufacturing plants.
- Visits to 30 bridge projects using lightweight concrete.

The data collected were studied, analyzed, and the results developed for presentation in this report.