

INNOVATIONS

IN CONTROLLED LOW-STRENGTH MATERIAL (Flowable Fill)

STP1459

TECHNICAL EDITORS:

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Innovations in Controlled Low-Strength Material (Flowable Fill)

Jenny L. Hitch, Amster K. Howard, and Warren P. Baas, editors

ASTM Stock Number: STP1459



ASTM International
100 Barr Harbor Drive
PO Box C700
West Conshohocken, PA 19428-2959

Printed in the U.S.A.

Library of Congress Cataloging-in-Publication Data

Symposium on Innovations in Controlled Low-Strength Material (Flowable Fill) (2002 : Denver, Colo.)

Innovations in controlled low-strength material (flowable fill) / editors, Jenny L. Hitch, Amster K. Howard, and Warren P. Baas,

p. cm. -- (STP ; 1459)

Proceedings of the symposium held June 19, 2002, Denver, Colo.

Includes bibliographical references.

ISBN 0-8031-3481-9

1. Fills (Earthwork)--Materials--Congresses. 2. Soil cement--Congresses. I. Hitch, Jennifer L., 1960- II. Howard, Amster K. III. Baas, Warren P., 1942- IV. Title. V. ASTM special technical publication ; 1459.

TA750.S96 2002

624.1'5--dc22

2004046380

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Foreword

The Symposium on Innovations in Controlled Low-Strength Material (Flowable Fill) was held in Denver, Colorado on 19 June 2002. ASTM International Committee D18.15 served as sponsor. Symposium chairmen and co-editors of this publication were Jenny Hitch, ISG Resources, Inc., Las Vegas, NV; Amster Howard, Lakewood, CO; Warren Bass, Ohio Ready Mixed Concrete Assoc., Columbus, OH.

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Overview

This book represents the work of several authors at the *Symposium on Innovations in Controlled Low-Strength Material (Flowable Fill)*, June 19, 2003, Denver, Colorado. This is the second symposium in the series concerning CLSM. The first symposium on The Design and Application of Controlled Low-Strength Materials (Flowable Fill) was presented June 19–20, 1997 in St. Louis, Missouri (STP 1331).

The use of Controlled Low-Strength Material (CLSM), or flowable fill as it is commonly known, has increased dramatically over the past two decades. It is continuing to gain acceptance in the construction industry despite the rather new technology and limited number of test methods available. Innovations in the field of CLSM continue to push the technology and create higher quality products. The purpose of this symposium was to continue to increase awareness of CLSM by presenting new design procedures, current research, unique project applications, and innovative installation techniques. The information presented is intended to help ASTM Subcommittee D18.15 assess the need for new or improved standards to add to the current five standards concerning CLSM under their jurisdiction.

CLSM is also known as flowable fill, flow fill, controlled density fill, soil-cement slurry, and K-crate™, among others. It is a mixture of cementitious material (portland cement or Class C fly ash), fly ash, soil and/or aggregates, water, and possibly chemical admixtures that, as the cementitious material hydrates, forms a soil replacement material. CLSM is used in place of compacted backfill or unsuitable native soil with the most common uses as pipe embedment and backfill. However, some of the many uses of CLSM are illustrated in the papers contained in this publication by Moberly et al, Jones and Giannakou and Crouch et al.

The symposium was divided into three parts to cover pertinent developments in the use of CLSM, as follows:

- *Innovative Ingredients
- *Engineering Property Analysis
- *Pipeline Applications

Innovative Ingredients

The intent of this section was to explore the use of non-traditional ingredients in CLSM and to determine their suitability or limitations. Three papers dealt with the use of non-traditional pozzolans in CLSM mixes:

Tarunjit S. Butalia, et al, discusses the use of two types of flue gas desulfurization (FGD) materials; spray dryer and wet fixated FGD material, in flowable fill as a replacement for conventional fly ash.

Tarun R. Naik, et al, utilized wood fly ash as the major component in CLSM and found that material to be an acceptable replacement for ASTM C618 fly ash.

Richard L. Moberly, Leslie B. Voss and Michael L. Mings described a case study of the stabilization of an abandoned limestone mine that utilized dry scrubber ash as opposed to ASTM C618 fly ash.

One paper dealt with the use of a local fly ash in CLSM mixes.

B.K. Sahu and K. Swarnadhipati utilized fly ash from the Moruple Thermal Power Station in Botswana to study the effect of varying lime and cement contents on the overall suitability of CLSM.

One paper discussed the use of non-traditional aggregates in CLSM mixes:

J. S. Dingrando, T. B. Edil and C.H. Benson studied the effect on unconfined compressive strength and flow of flowable fills prepared with a variety of foundry sands used as a replacement for conventional fine aggregate.

Engineering Property Analysis

Determining the engineering properties for certain applications of CLSM is very important. This section includes papers that utilized existing ASTM test methods as well as explored new methods to measure parameters, such as excavatability.

Four papers dealt with the engineering properties of CLSM:

L.K. Crouch and V.J. Dotson tested CLSM mixtures to see if they would pass ASTM D6024 in six hours or less, produce little or no bleeding or shrinkage, have a flow greater than 222 mm per ASTM D6103, and have a 24-hour compressive strength greater than 201 kPa as per ASTM D4832.

H. Tripathi, C. E. Pierce, S.L. Gassman and T.W. Brown evaluated several standard and non-standard methods to measure flow consistency and setting time on various field and laboratory mixes.

L.K. Crouch, et al, studied the relationship between compressive strength and long-term excavatability for twenty-three flowable fill mixtures.

M. Roderick Jones and Aikaterini Giannakou examined the performance of a range of foamed concretes for use as controlled thermal fill (CTF) in trench fills and ground slabs. Performance criteria included compressive strength, capillary sorption, resistance to aggressive chemical environments, resistance to freezing and thawing, thermal conductivity and drying shrinkage.

Pipeline Applications

As previously stated, one of the most common uses for CLSM is pipe backfill. This section is devoted to that topic with two papers that address some of the issues related to pipeline design.

Teruhisa Masada and Shad M. Sargand reported the results of a research project designed to evaluate the feasibility of constructing an economical drainage pipe system using a flexible thermoplastic pipe and flowable fill.

Fred P. Hooper, et al, analyzed the permeability of backfill materials before freezing, during freezing and after thawing in order to determine their suitability as utility line backfill.

The papers contained in this publication highlight the innovations in technology, test methods and material science that have occurred during the evolution of CLSM. The information presented by the authors will be extremely helpful to ASTM Subcommittee D18.15 in their quest to assist the industry by providing up to date and meaningful standards on CLSM.

ASTM Standards on CLSM

The Appendix to this STP contains the current ASTM Standards on CLSM developed by Committee D18 on Soil and Rock, as follows:

D4832 Standard Test Method for preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

D5971 Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material

D6023 Standard Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)

D6024 Standard Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application

D6103 Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

Acknowledgments

We wish to thank all the authors and reviewers whose hard work made the symposium an interesting and very useful forum for discussing the current use and intriguing innovations of Controlled Low-Strength Material. We would also like to thank the staff at ASTM for their enormous help in organizing this symposium and STP.

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ISBN #0-8031-3481-9
Stock #: STP1459