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JUL 05 1984

101/JTB/84/07/3/0

- 1 -

MEMORANDUM FOR: Robert J. Wright
 Repository Projects Branch
 Division of Waste Management

FROM: John T. Buckley
 Engineering Branch
 Division of Waste Management

SUBJECT: CORRECTION IN PAGE v.5 OF THE DSCA

A short time ago I was informed of a typing error in the BWIP DSCA which was published in March 1983 as NUREG-0960. The error occurs on page v.5 of NUREG-0960 Vol.2 which is entitled "Draft Site Characterization Analysis of the Site Characterization Report for the Basalt Waste Isolation Project."

Attached for your transmittal to BWIP is a copy of the published version of page v.5, a copy of the corrected page v.5 and a copy of the original wording as presented to the NRC by Engineers International in February, 1983.

If you have any questions regarding the contents of this memo please contact me.

ORIGINAL SIGNED BY

John T. Buckley
 Engineering Branch
 Division of Waste Management

Enclosure:
 As stated

WM Record File. 101.1 WM Project: 10
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2.3.1 Engineering Mechanics

Design approaches based on engineering mechanics considerations are the rock classification schemes, and analytical solutions to analyze stability. Rock classification systems address most of the factors governing the stability of underground openings in rock, i.e., basic rock strength, fracturing, water conditions, and overall geologic setting. The RMSD method proposed by Kendorski (1980) is basically a discounting method in which the intact rock strength is discounted according to the nature and degree of fracturing to obtain the rock mass strength. This value can be used for analytical computations as well as an indicator of overall rock mass competence. The Geomechanics System of Bieniawski (1979) develops a relationship of span versus standup time. The Q-System of Barton, Lien, and Lunde (1974) is fairly simple, but is not recommended for the design of shotcrete and rock reinforcement. The system proposed by Terzaghi (1946) computes a dead rock load due to loosening, and is widely used for the design of steel arch support in tunnels.

These systems either enable or directly yield generalized support recommendations. Application of these systems to circumstances outside the classification data base requires discretion by the user. Thus, the particular requirements of nuclear waste repositories, especially thermomechanical effects, will require some modification of the direct results obtained from classification systems before an adequate preliminary design is obtained for any single repository concept. However, various repository concepts can be readily compared for long-term stability and constructibility using classification approaches. Typically, recommendations from the various classification systems are compared to obtain preliminary rock mechanics design concepts.

Classical engineering mechanics approaches are based on arriving at a balance of forces acting on an opening. Driving forces are the rock loads, and resisting forces come from the rock mass competence and the support system. The in situ material properties of the rock and support must be known for such an approach to be meaningful.

Simple elastic theory (Obert and Duvall, 1967) gives a first approximation of the distribution and magnitude of stresses and distressed zones surrounding an opening. However, the assumptions of homogeneity, isotropy, and linear elasticity implicit in elastic theory are seldom met in rock masses. Elastic theory also does not allow for the effects of rock reinforcement. However, even with these limitations, simple elastic analyses yield useful, though conservative, information for conceptual design of structures in rock.

Elastic-plastic ground reaction curve methods seek to match the support to the rock mass such that the amount of deformation allowed for corresponds both to the peak rock mass shear strength and the peak deformation resistance of the support (Egger, 1980). For the optimum use of the method, proper timing of support installation is essential. While the deformation of the support can be fairly readily evaluated, it is seldom possible to predict the ground behavior characteristic from basic geomechanics data. Field measurements of rock mass behavior are necessary, and preliminary estimates can be obtained from underground test facilities within the horizon of interest. During construction,

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DESIGN OF STABLE OPENINGS

prepared for

**U. S. Nuclear Regulatory Commission
Washington, DC**

February 1983

**NRC Contract No. NRC-02-82-030
Task Order 003 - Task 1**

**Engineers International, Inc.
Westmont, IL**

carried out (analytical techniques). A comparison of the designs is then possible, perhaps based on cost and technical criteria. A few alternatives are then selected for detailed consideration, in which the interaction of all critical design factors is evaluated through numerical modeling; this design phase should be supported by in situ testing for specific input parameters. From this effort, design specifications and performance criteria are formulated. Finally, the conformance of the rock mass behavior with performance criteria is established by monitoring.

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