GEOTEchnICAL HAZARD REVIEW

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ABSTRACT

Engineering projects often run into “difficult” ground conditions which cause delays, failures, hugely increased costs or even abandonment with consequent disputes and claims. Pertinent questions are “what constitute difficult conditions?” and “how might they be foreseen?” and these questions provide the focus for this paper.

Geological, geotechnical and hydrogeological models for engineering projects (simplified representations of the ground) need to be developed in a systematic manner. Within these models, the potential hazards associated with material (small) and mass (large) scale attributes of the geology, the environmental setting and the influence of the engineering works themselves need to be considered individually and in a progressive, systematic manner. This paper introduces the concept of a Geotechnical Hazard Review with reference to examples from various engineering works.

INTRODUCTION

Disputes relating to ground conditions are often based on the premise that the conditions were unforeseen or unforeseeable. The questions of “what constitute difficult conditions?” and “how might they be foreseen?” are the focus for this paper. A systematic approach is introduced whereby the various geological and environmental factors that might conceivably affect the success of the project are considered.

WHAT CONSTITUTE DIFFICULT GROUND CONDITIONS?

Often in engineering projects, the extent of difficulties associated with ground conditions are not foreseen prior to something going seriously wrong. The difference between unforeseen (not predicted) and unforeseeable (outside common experience, not to be expected and without indications) is important.
It is important that ground conditions, which have the potential for causing problems, are recognised at the correct time and dealt with adequately by the designer. Following failures of designed works, it is often found that the model of ground conditions was inadequate, either because some geological feature or property had been missed or overlooked during investigation, or because its significance had not been recognised. It is apparent that the "unforeseen" condition might at least have been anticipated to some degree, had a more thorough approach been taken to weighing up the geology and environmental setting. Even where nothing major goes wrong in many projects, it is often a matter of good fortune (absence of difficult conditions) rather than the result of a proper process of assessment and focused investigation.

In practice, it is dangerous to disregard any property (e.g. chemistry, fabric, structure) of material or mass without careful consideration of its potential effect on the proposed works, both during and post-construction. Examples of the severe influence of apparently minor factors will be given later.

GEOTECHNICAL HAZARD REVIEW

A broad overview of the geological and environmental setting can provide many insights into the likely difficulties to be faced throughout an engineering project. DeFreitas (1993) suggests that, when dealing with works of any significant size, careful consideration should be given to three questions:

a) what do we know?
b) what do we need to know?, and
c) what do we not know?

Each question should be considered at an early stage with reference to possible design solutions and methods of working. The site investigation should be specified accordingly. This might seem obvious but, for many reasons, it is rarely done systematically or comprehensively.

It is suggested that potential hazards be considered in a formal way through which potential problems are identified so that they can be categorised and mitigated against as far as possible. Such a systematic way of approaching hazard and risk is becoming common throughout civil engineering (Godfrey, 1996; Brown, 1999).

An approach for carrying out a Geotechnical Hazard Review is described here with reference to three equations (Tables 1 and 2). The equations were originally conceived by Knill and Price (Knill, 1976) and subsequently used by Price and Lumden as the framework for teaching advanced courses in engineering geology at Delft University (Holland) and Leeds University (UK) respectively (Henchler, 1994; 1996). The equations provide a useful way of and, essentially a checklist for, approaching geotechnical aspects of many engineering works. The equations focus attention progressively on geological materials (mineralogy, fabric, texture and hence intrinsic engineering properties), then more broadly to include mass features (discontinuities and overall geological structure), environmental setting and, finally, the influence of the engineering work themselves.