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1983/56. Seismic refraction survey of a proposed railway cutting east of Conara.

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Abstract

The site of a proposed railway cutting is underlain by variably weathered dolerite. A seismic refraction survey indicates that the dolerite will be rippable to depths of 1.5 to 6 m below natural surface. No batter stability problems are anticipated.

INTRODUCTION

At the request of the Australian National Railways Commission a reconnaissance seismic refraction survey was carried out at the site of a proposed railway cutting on the Fingal Line about 10 km east of Conara [EP447699]. The purpose of the survey was to determine the extent of rippable material and to provide information for the design of batter slopes.

GEOLOGY

As reported in our letter of 19 October 1983, the site of the cutting is underlain by dolerite of Jurassic age. The two test pits exposed 0.6 to 0.7 m of silty clay topsoil with rock fragments overlying highly weathered dolerite with open and clay-filled joints. It is anticipated that variably weathered dolerite will occur beneath the topsoil to the total depth of the proposed cutting. Whether or not the dolerite is rippable depends on the weathering and strength of the rock and the nature of the defects or joints. If the dolerite is highly weathered, if its strength is not high, and if it contains open or clay-filled joints it will be rippable. On the other hand fresh, high strength rock with tightly closed joints will require blasting.

SEISMIC REFRACTION SURVEY

Seismic refraction surveys measure the velocity of shock waves through the ground. These waves provide an indirect way of assessing the quality of the rock. The velocity of shock waves in low strength, weathered, open jointed rock will be lower than in high strength, fresh, tightly jointed rock.

A 12-channel Nimbus Model ES1210F seismograph was used for the survey. Three consecutive spreads, each with a five metre geophone spacing, were laid out along the deviation centreline between 9.425 km and 9.590 km. Eleven shots were fired with gelignite and electric detonators. Shots were fired at both ends and in the middle of each of the three spreads, and two extension shots were fired 60 m from each end of the central spread. A short fourth spread with geophone spacings of one and two metres was fired close to 9.480 km in order to better define the velocity of the near-surface layers.

Similar velocity profiles were obtained for each of the three main spreads. Critical depth and reciprocal methods were used to calculate the depths to the various velocity layers. The results of the seismic refraction survey are summarised in Table 1. It should be emphasised that seismic refraction interpretative methods involve the assumption of a layered earth model. Such a model is often a good approximation for sedimentary rocks but it is less appropriate for irregularly weathered igneous rocks such as dolerite. Previous excavations into dolerite have shown that fresh rock with tightly closed joints could occur within masses of weathered, more

jointed rock. Such situations can be completely missed by a seismic refraction survey. In general, irregular variability within the dolerite can lead to error in depth calculations and pockets of fresh, tightly jointed, unrippable rock can occur in lower velocity zones.

Table 1. RESULTS OF SEISMIC REFRACTION SURVEY

Layer number	*Velocity (m/sec)*	*Thickness (m)*	*Total depth (m)*	*Geological interpretation*
1	300 to 400	0.5 to 1	0.5 to 1	Silty clay topsoil, rock fragments
2	1300 to 2000	1 to 5.5	1.5 to 6	Dolerite rock mass, weathered, some open or unfilled joints
3	2500 to 3300	4 to 12	8 to 18	Dolerite rock mass, slightly weathered, few open joints
4	4000 to 6000	-	-	Dolerite rock mass, fresh, tight joints

EXCAVATION CONDITIONS

Layer 1 (see Table 1) consists of soil with some rock fragments. This layer varies in depth from about 0.5 to 1.0 m on the part of the proposed route tested. This material can be easily excavated by light machinery.

Layer 2 consists of variably weathered dolerite. Some joints will be slightly open or filled with clay. Most of this layer will be rippable with a heavy bulldozer such as Caterpillar D8 or D9, although there may be isolated pockets of unrippable material.

Layers 3 and 4 will consist mainly of fresh or slightly weathered dolerite with tightly closed joints. It will not be possible to excavate these layers with a bulldozer and blasting will be required.

The interpretation of the seismic refraction survey indicates that the boundary between rippable and unrippable material in the section tested will be an irregular surface between 1.5 m and 6 m below the natural surface.

BATTER SLOPES

The soil layer at the top of the cutting will generally be less than one metre thick and should be stable with a batter slope of 1 to 1 (45°).

The stability of batter slopes in dolerite is directly dependent on the orientation and continuity of joints. This information cannot be determined from a seismic refraction survey. However, the Department of Main Roads has found that dolerite with a velocity similar to Layer 2 is usually stable with batter slopes of ½ to 1 (63°) and dolerite with velocities similar to Layers 3 and 4 is usually stable at slopes of ¼ to 1 (76°). If joints dip into the cutting or intersect to form wedges that dip into the cutting, slopes of ¼ to 1 may not stand without support. This may be the situation in some parts of the cutting but it is considered unlikely that Layer 2 would not be stable at 3/4 to 1 (53°) and that Layers 3 and 4 would not be stable at ½ to 1 (63°). Further comment on batter stability would be possible after excavation has started at the site and the orientation and the continuity of joints can be measured. Pre-splitting is recommended

as it usually improves batter stability.

CONCLUSIONS

The site of the proposed railway cutting is underlain by dolerite. This rock is likely to be encountered over all of the site and for the entire length of the excavation.

The seismic refraction survey between 9.425 km and 9.590 km indicates that the dolerite is variably weathered and jointed. The dolerite should be rippable with heavy machinery to depths of between 1.5 m and 6 m below the natural surface.

It is not possible to predict the steepest stable batter slopes, but ½ to 1 (63°) would be suitable for planning purposes. The lower sections of the cutting in fresh or slightly weathered rock may be stable at slopes of ¼ to 1 (76°).

The Department of Main Roads has considerable experience in the excavation of cuttings in dolerite and it is recommended that DMR be contacted if further advice is required.

[14 November 1983]