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1982/32. Rock slope stability at the Giblin Street quarry

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Abstract

The slope stability of the rock faces at the Giblin Street quarry has been investigated. The quarry exposes up to 65 m of mainly fresh, extremely high strength dolerite. The main face has an overall slope of about 45°. Joints divide the dolerite into columns. Rockfalls of up to 1500 t have occurred in the past. The main mechanism of failure is by toppling of columns, and there appears to be no risk of major slope failure. It is recommended that protection against rockfall be provided by a bounce pit and a rock and earth mound. Traffic and noise are not likely to cause rockfall. The quarry floors will require drainage. The overburden spoil dump is stable. If adequate protection is provided against rockfall, the quarry floors can be developed.

INTRODUCTION

In a letter dated 22 June 1982, the Hobart City Council requested that the Department of Mines undertake an investigation of the Giblin Street quarry [EN238528] and provide the Council with information on the following matters:

(1) Stability of the quarry rock faces.
(2) The risk of rockfalls arising from vibrations, noise, or an increase in vehicular traffic associated with any industrial or recreational use.
(3) Drainage problems, erosion or landslide areas.
(4) The risk to the public if people-oriented activities were allowed in the quarry.
(5) Areas to be avoided in any building construction.
(6) Details of steps needed to be taken to render safe any rock faces considered dangerous.

Due to cost limitations imposed by the Council, field work was restricted to one day; the site was investigated on 19 August. The investigation involved an examination of the quarry faces, the mapping of potential and existing failures on the various bench levels in the main quarry, and an assessment of the overall stability of the quarry complex including the overburden spoil heap.

This report describes the results of the investigation.

GEOLOGY

The Hobart Sheet of the 1:50 000 Geological Atlas series (Leaman, 1973) shows the quarry complex to be sited in dolerite of Jurassic age.

A section of dolerite up to a height of about 65 m has been exposed in the main quarry area. The dolerite is medium-grained, fresh, and of extremely high strength, except for the top 5 m to 6 m where the rock is highly weathered close to defects and extremely weathered (soil) seams occur.

The quarry to the south of the main pit area is mainly in dolerite, with some sandstone and siltstone. The dolerite in the western face is fine-grained and weathered to a depth of 10 m or more. Weathering is less extreme on the eastern face of this quarry.

EXAMINATION OF THE MAIN QUARRY FACE

Slope geometry

The main quarry face has an overall slope of about 45°, made up from five benches with about 70° faces. Individual bench heights vary between about 7 m and 23 m, while bench widths vary from about 6 m to 15 m.

Joint geometry

Near vertical joints divide the dolerite into columns with diameters ranging from 0.6 m to 3 m. The joints tend to dip steeply (75° to 90°) towards the south and east, causing the columns to appear tilted towards the north and west (*i.e.* out of the main face). Irregular, discontinuous flat lying joints divide the columns into lengths varying from one to six metres.

Rock slope instability

The slope crest and all the benches in the main quarry area were inspected. Tension cracks and bench failures were observed and recorded.

Tension cracks, which indicate the onset of instability, have developed mainly on the natural surface at the top of the face. They have formed in the zone of weathered rock, up to 3 m behind the quarry face. Only one significant tension crack was noted occurring in the fresh rock on the lower benches. This crack was about 9 m along and up to 1.5 m behind the quarry face.

Numerous bench failures were observed at all levels of the quarry. These failures varied considerably in size (50 - 1500 t), and some are recent failures, having developed since the last aerial photography survey was conducted in the area during March 1982.

Toppling failure appears to be the main mechanism producing rock falls on the slope. The size of columns or blocks that topple is determined by the frequency of the flat lying joints.

One recent failure (post-March 1982) deserves mention, as its effects are evident over the whole quarry face and serves as a useful indicator in the planning of remedial or protective measures.

It is estimated that about 1500 t of material was involved in the failure which took place in the weathered zone at the top of the quarry face. About 90% of the material involved was retained on the first bench with many blocks of about 2 to 10 t; the largest single block measured had a mass of about 30 t. The debris on bench 2 amounted to about 100 t with blocks up to five tonnes. Benches 3 and 4 retained about 5 t and 3 t respectively with boulders up to one tonne. A single boulder of about six tonnes reached bench 5 (the main quarry floor) making impact about 8 m from the face and coming to rest about 3 m further on.

EVALUATION OF THE ROCKFALL HAZARD

The overall geometry of the slope, and the orientation and the extent of joints, indicates that major slope failure is most unlikely.

However local rock falls will continue to occur, especially towards the top of the slope in the weathered zone, as a result of natural degradation processes. Some instability can also be expected to continue on the lower benches as a result of blast damage incurred during quarrying operations.

Rock falls could occur at any time. Direct observation has shown that boulders of up to six tonnes are capable of reaching the base of the slope from the higher benches.

PROTECTIVE MEASURES

Several approaches can be taken to render safe those areas in the quarry which are potentially hazardous to any future development proposal. Remedial measures can involve either stabilisation methods which aim to eliminate the likelihood of further instability, or protection methods which are designed to intercept and confine falling material to the base of the slope.

Only protective measures are considered here, as it is our opinion that in this situation, it is more appropriate to control rather than prevent rock falls.

Rock fall protection measures must be designed to protect against the various ways in which rock falls can reach the bottom of the slope. Rocks can arrive by free fall, bouncing, rolling, or sliding. Bouncing rocks are the most difficult to predict due to the infinite number of possible trajectory paths.

The protection system proposed assumes that future development and usage is confined to the main quarry floor areas and access to the benches on the main quarry face is restricted.

It is recommended that a structure comprising a bounce pit and a rock and earth mound be placed along the base of the major faces. This method should prove to be relatively inexpensive (due to the availability of materials on site), simple to construct, and easy to maintain.

It is envisaged that the bounce pit should contain between 0.3 m and 0.5 m of sand, gravel, loose soil, or any energy absorbing material. The protective mound could be constructed from the boulder size material present in the quarry and covered with soil. A typical section of the protective measures proposed is detailed in Figure 1.

A fence on top of the mound would be necessary to prevent public access to the bounce pit and provide a final line of defence against small rock fragments.

Three grades of protective measures are given in Table 1, based on the height of the protective mound and the distance of the mound from the face. The fourth grade refers to rock faces which do not require a protective mound. The grade of protection required for different parts of the quarry is shown on Figure 1. This preliminary assessment is provided for planning purposes to indicate our opinion of the type of protective measures required. The final choice and details of protective measures will depend on the specific development proposed.

Any vegetation established on the mound, in the bounce pit, or on the benches will generally have a beneficial effect in reducing the energy of falling rocks.

Table 1. RECOMMENDED BOUNCE PIT GEOMETRY

Grade	*Distance of mound from face (m)*	*Height of mound (m)*
1	12 to 15	2
2	8 to 10	1.5
3	4 to 6	1
4	Requires minimal remedial measures	

TRAFFIC AND VIBRATIONS

It is considered that normal vehicular traffic on the quarry floor will not increase the risk of rockfall. Noise and vibration caused by light industry is unlikely to cause rockfall. If it is proposed to establish heavy industry on the floor of the quarry, the potential effects of noise and vibrations should receive further consideration.

DRAINAGE

The main quarry floors are flat and ponding of water occurs after rain. Drainage will have to be considered as part of any proposed development.

OVERBURDEN SPOIL DUMP

The overburden spoil dump was examined and there is no evidence of slope instability. Ponding of water will occur on the flat top of the dump. The fill may be quite variable and foundation conditions should be investigated if buildings are proposed.

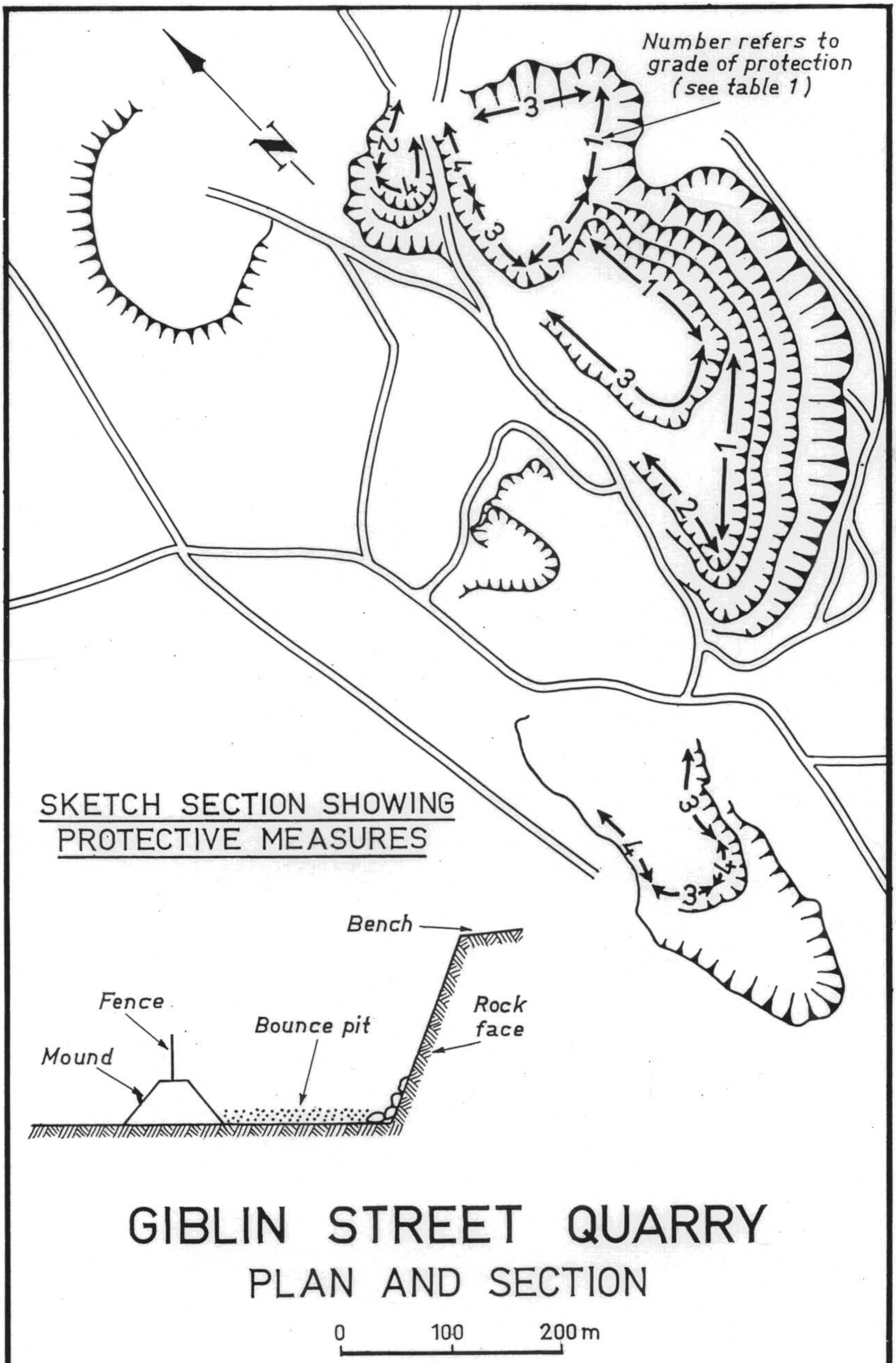
MAIN CONCLUSION

The main quarry floors of the Giblin Street quarry could be used for a variety of purposes if adequate protection is provided against rockfalls.

REFERENCE

LEAMAN, D.E. 1973. Geological atlas 1:50 000 series. Zone 7 Sheet 82 (8312S). Hobart. *Department of Mines, Tasmania*.

[1 September 1982]



GIBLIN STREET QUARRY

PLAN AND SECTION

Fig. 1

5 cm