

EFFICIENCIES IN ALPINE UNSEALED ROAD MAINTENANCE

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Abstract

(Traduccion a español en paginas 8 y 10 en AZUL)

Key Words: Unsealed, Alpine roads, profiler blades, polymer stabilization, unsealed maintenance,

Introduction

Rural regional alpine roads have special conditions related to their Geographic isolation. These areas are also prone to sever weather variations & conditions as well as high seasonal, intermittent use.

The distance to quarry and material sources creates inefficiencies and has been exacerbated by the closure of Parks Vic/DSE pits and material sources within national park areas.

The high environmental value of region limits materials and methodologies as well as water sources and restrictions to access “off road” water sources.

Alpine Shire council has taken an innovative approach in its road management procedures based on modernised practices and material use.

Geographic isolation

Due to the nature of the natural topography of alpine terrain isolation of sites is a normal occurrence. While sites may be spatially close distance between sites can be vast.

Valley roads are of a herringbone or tree nature rather than a grid that exists within the plains below the alpine ranges.

The geographic nature of alpine areas is not only influencing the relationship between the location of resources in labour and machinery and the area of operations (works site).

The location and access to water gravel and material sources, areas of high significance (e.g. endangered native grasses) etc. may be reviewed to determine efficiencies. These geographic impediments are the primary source of unproductive works in comparison to works on the “flat lands”.

Effect of Topography on Route Selection

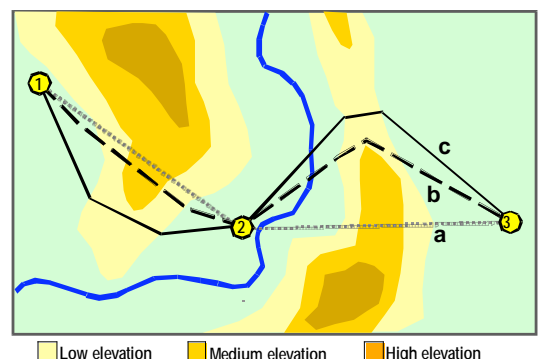


Figure 1 the difference in route selection due to geography

As above the selection of more efficient routes laden and/or un-laden around or over terrain can be calculated as to the efficiency in costs for either option.

As below accessibility calculations and modelling methods exists within the freight logistics industries. These models are comparable to servicing road networks and allow the formulation of strategies to overcome or at least minimise some of the

geographic issues though route and program selection as below.

Geographic Accessibility

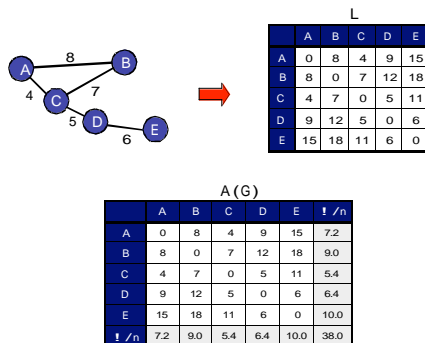


Figure 2 Accessibility matrix for route selection and maintenance programming

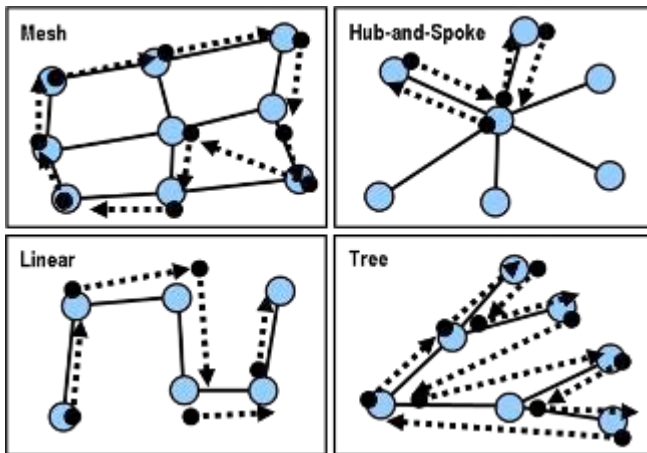


Figure 3 Examples of route programming

Sever weather variations & conditions

Alpine areas are prone to rapid weather changes and sever variations in climate in comparison to costal and lower plains terrain.

The changeability of conditions makes maintenance difficult when trying to utilise in-situ moisture content in spring and autumn rather than the dry periods of summer and in accessible periods due to snow.

The occurrence of heavy rainfall within isolated areas can cause flash flooding and major problems in drainage overload as well as drainage obstructions. This can lead to sections of road being under water due to surface flooding for periods of time leading to

The temperature variances of below 0 and over 40 degrees Celsius



Figure 4 The Drago Road Under snow

As shown above in the snow covered pavement reaches well below sub zero temperatures at night and results in cracked pavements whose permeable nature results in rapid deterioration. The freeze thaw effect is also a deterrent to any conventional sealed pavements and result in the use of McAdams free draining seeled pavements being used.

Freeze thaw cracking can occur at any season and can produce rapid degeneration, especially in conjunction with wet periods, heavy dues, mist and drizzle which is frequent in alpine areas.



Figure 5 Grading Snow from alpine roads

Seasonal, intermittent high use

Many of the unsealed alpine roads are of a high tourism value. That is the high environmental value is transposed to tourism and recreational activities. This value coupled with the seasonality of the activity and regional access of many of the recreational pursuit's undertaken results in high but

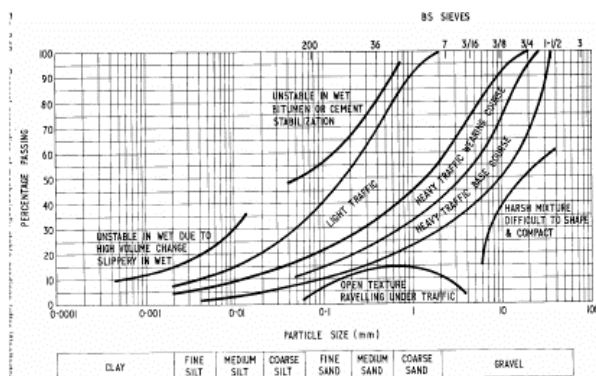
intermittent use. This can be due to deer hunting, 4x4 tracking, snow play activities and camping/trekking. Also commercial activities i.e. logging can also increase percentage of commercial traffic volumes.

Due to the high traffic volumes deterioration of road surfaces can be rapid and variable due to weather and

Distance to quarry and material sources

Due to the distance increasing to materials through the rationalisation of existing sources as well as the increased costs in transportation and fuel costs all transportation to and from sites needs to be minimised. These increased costs are exaggerated by the distances and remote nature of alpine roads.

Being able to modify the existing pavement materials to match suitability of material to traffic types and user requirements is essential for attaining efficiencies. If the existing pavement form and type is known and only that which is not present is added then a pavement can be modified to correspond to the specification matching the use with the minimum of cartage and cost.



The modification through binders that require little transportation such as polymer and resins etc is a cost effective method of achieving optimum densities and prolonged pavement life without requiring the cartage of materials over distance.

Closure of Parks Vic/DSE pits and material sources

The Department of Sustainability and Environment and Parks Victoria are

developing sustainable practices in resource management as well as developing the rehabilitation of older rock quarries and pits. Many of these areas no longer conform to modern best practice as well as being seen as a “scar” upon an environmental landscape.

The closure of these sources of material exaggerates the effect of cartage cost and geographic isolation. This also affects the availability of areas to be used as stock sites and staging areas.

High environmental value of region

The uses of materials that are unsatisfactory within environmental standards or present a risk to the area require either prohibition or mitigation. The use of ‘sump oil’ as a dust suppressant is forbidden and any use even if allowable would raise political and environmental concerns within the management of the parks and by the users of the alpine recreational areas.

Any material that presents a risk requires mitigation that can raise the establishment costs due to preventative measures required. Dust suppressant (magnesium Chloride, $MgCl_2$) can be applied as liquid or powdered magnesium chloride to control dust and erosion on unimproved (dirt or gravel) roads. There hygroscopic properties make it absorb moisture from the air, controlling the number of small particles which become airborne. However the use of “salts” in the head of catchment areas where salinity is an issue down stream is seen as an unfavorable practice. A spillage of materials can affect flora negatively and thus requires greater care and cost.

Materials used need to be non prescriptive environmentally to lower costs and ensure positive perceptions by government agencies and public users of the works undertaken. The use of inert polymer is an option that extends pavement life but has no environmental concerns.

Water sources and access “off road” restrictions

Due to the geographic nature of alpine areas access to water for construction purposes is limited and geographically isolated. This

extends travel time and results in greater costs in transportation



Conclusion

Utilize existing pavement Material

Alpine Shire has managed to increase pavement life in some cases by 300% (as measured in decreases in maintenance hours) and increased road standards.

A homogeneous base course/sub base is formed that reacts consistently across the whole pavement requiring larger interventions less frequently. This is where 1-5% is prone to deteriorate requiring intervention due to material type. The bridging of these areas is undertaken through several methods. This merges material types lowering the suitability of adjoin sections and raises that of the inferior sections. The use of polymer stabilizer also facilitates a uniform CBR between materials types.

As an example where an intersection deteriorates quicker than the main pavement the need to intervene more regularly only for that section needs to be addressed so that the intervention is to be covered only when the whole pavement length requires maintenance.

This homogeneous surface requires interventions concomitantly this allows for better logistics and decreased proportional establishment costs to actual maintenance.

Grader blades, profiler heads

The use of “Sandvik” grader blades assists in the winning of material from the existing bedrock that protrudes from the road base in places as well as breaks up existing “floaters” (boulders within the base course to sub grade). The fracturing of this material returns sharps/shards to the pavement allowing for mechanical interlock.



The use of these “teeth” produces production savings in less downtime in changing blades and savings in the cost of cutting edges worn through in tough alpine rocky terrain.



Rock Breakers

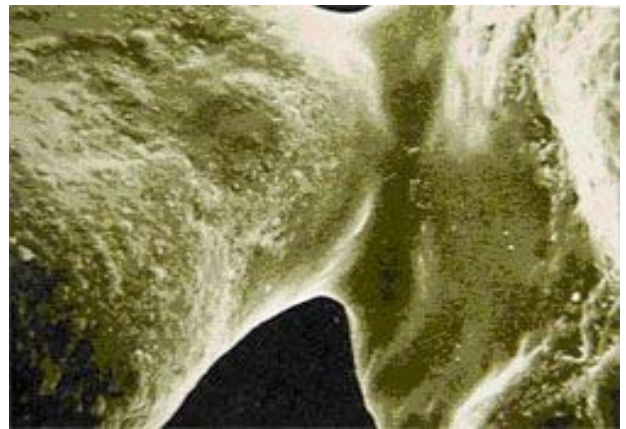
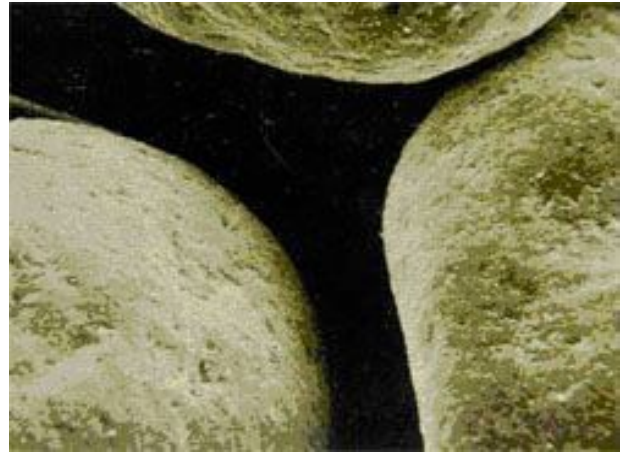
The use of rock breakers is similar to that of the profiler grader blades in principal. The concept is either to break up imported rock or rock in situ.



The use of polymer as a binder in conjunction with rock breakers is a similar concept to that of its use in combination with grader profiler blades

Stabilise with agent (PolyCom)

The use of polymer stabilizers is an adjunct to all other improved methodologies. This is added to other practices and while not essential to it, it has been found to extend each of the treatments/efficiencies exponentially. As an example the use of the profiler head grader blades in conjunction with PolyCom has been found to bind the fractured material resulting in an exceptionally tight surface adding to the materials mechanical interlock. This can be seen in the adhesion of sand particles as below.



The decrease in water usage required to compact and construct roads has been found to be over 1/3 to 1/2. This, while being an excellent environmental saving, is an efficiency and productivity attribute allowing for greater savings in time. This time saving can be converted to greater works accomplishment to extend intervention timings and raise service levels.

As shown in the following photo the only added equipment required is an educator to mix PolyCom with the water in a water cart.



The use of PolyCom as a stabilizer increases pavement density quickly without decreasing flexibility utilizes the same methodology, same equipment, minimum transport and requires no added time and/or effort. This added benefit to the new processes has produced savings and better pavement results.



The high viscosity of the water treated with PolyCom prevents evaporative loss and allows retention of moisture in the pavement during construction. The slimy consistency allows particles to easily compact without the need for excessive moisture to allow the pavement to condense.

The reduction in freeze thaw

The reduction in freeze thaw effects through modified freeze point and flexibility of the polymer prevents deterioration under snow and ice. The impermeability of surface as below prevents water ingress to the pavement and thus prevents freeze thaw also.



Larger interventions – less frequently **Modeling**

There are various methodologies under the use of logistics systems analysis and distribution/production management theory to review systems. Any theorized, practical approach that analyses the whole costs of road maintenance in line with geographic issues is better than reactionary works.

A simplistic model is that of travel (establishment time) seen as cost vs working time seen as revenue and the derived benefit. Using these models will allow informed decisions as to the methodologies to be employed.

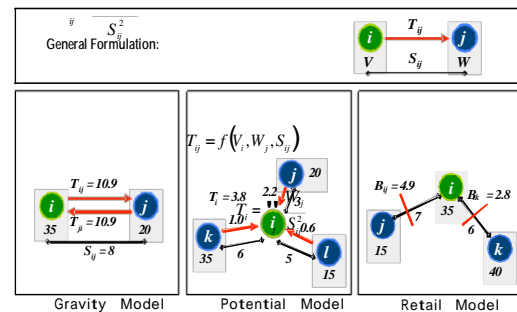
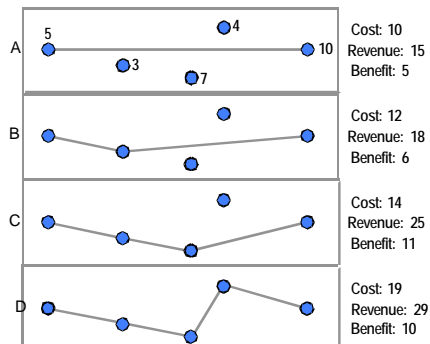
Better route planning, combined with less movement from site (over existing roads) to water and resource locations result in less damage to existing pavements. A PolyCom Pack weighs 2 Kg and will treat on average 100t of material, this calculated as a reduction in tonnes/km as well as the reduction in water cartage as t/km is a major saving in less damaged pavements during construction and maintenance activities.

For us at the Alpine Shire Council the savings have been made in actual dollars and improved road conditions which translated to greater service standards, less customer requests, higher public perceptions and

sustainability/preservation of high value environmental value areas.

Three Basic Types of Interaction Models

Cost, Revenue and Level of Network Coverage



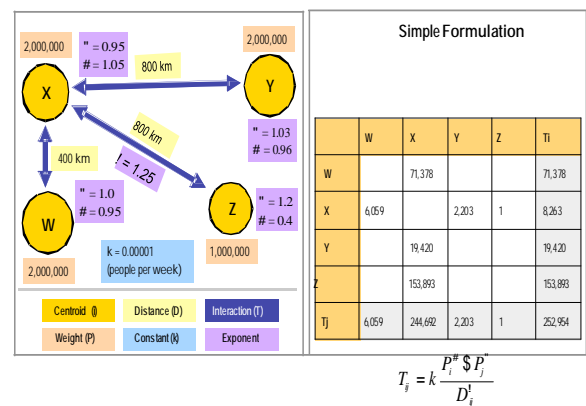
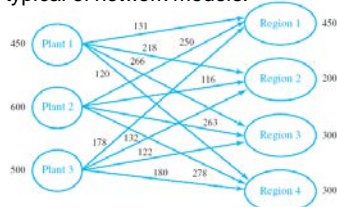
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Application of a Simple Spatial Interaction Equation

The general principals can be followed thus resolving the need for overly complicated models in distribution/production logistics management. This process is generally beyond the normal skill sets of operational and managerial roads management/maintenance staff. As below examples are highlighted as possible methodologies. However the principal is simple.

Representing as a Network Model

- A network diagram of this model is shown here. This diagram is typical of network models.



Epilogue

As the approach to programming and methodology of works evolves, the use of new and innovative practices continues. The use of PolyCom as a soil stabilizer is now proven but the work continues. As an anionic stabiliser it has been trailed with the use of Multibond CRS Emulsion to apply a 7 mm seal. This seal has been found to penetrate into the pavements very well allowing to be "drawn in". The positive results show that the PolyCom acts as a flux and bonds the sealing aggregate and pavement exceptionally well. However this has not been proven in the longer term and the effect on the bitumen drawn from the suspended emulsion is not known.

The works done with emulsion seals over a pavement made of wet mixed (with PolyCom) 14mm FCR on trails and paths has been very positive also. This allows paths to be constructed quickly with minimum plant and

pavement allows stone and emulsion to be laid concurrently as the emulsion breaks on contact. It is possible that a short delay in laying the sealing aggregate may prevent this stone from binding and result in stripping. This has not been experienced in our methodology.

Sections of unsealed road prone to rapid deterioration (steep hill sections, intersections with high shear stress etc.) have been treated with emulsion seals. The theory is that as these areas are done they will be left **unmaintained** until they become beyond functionality. At this point they will be ripped and the treatment reapplied. Over a period of many years (if the seal lasts for 3-10 years) the pavement will achieve a BTB (bitumen treated base course) and deteriorate less rapidly each cycle.

DO MORE, LESS OFTEN TO LAST LONGER WITH WHAT YOU HAVE!

Case Studies

Wematong Pit

Alpine Shire council gained access to the spoil from the AGL Hydro tunnel project. This was a 100% granite with 0% PI and was to be stockpiled requiring a low maintenance access track to the Pit to facilitate all weather access to commercial vehicles

PolyCom was used to stabilize the material due to its low PI, high dust/fines and poor grading. Site area was 100 m X 5 m and depth varied from 100mm to 300mm due to a drainage ditch midway along the access track.

PolyCom requirement was determined at 6kgs in total using the matrix calculator. The source material required 18000 litres of water to reach OMC translating to a mix ratio of 1kg per 3000 litres water.

As material had been soaked with constant rain prior to treatment adding PolyCom at normal mix ratio of 3000:1 was impossible of 1000:1 was adopted adding the 6kg of PolyCom without not OMC on completion of the treatment.

Material was stabilized in the stockpile by wetting by water cart and blade mixed with road grader to ensure consistency, placed onto the access track in layers and compacted.

Results

Due to the high moisture content and damp weather conditions the road remained highly flexible for several weeks without deforming. Once dry back was achieved the roadway has retained the original shape and withstood continued heavy loads in and out of the pit. Under several periods of heavy rain the roadway was partially submerged and trafficked with truck and trailers brining in spoil. No maintenance has been carried out over a 9 month period and the carriageway shows no sign of deformation or significant wear.

Debido al alto contenido de humedad y las condiciones meteorológicas húmedas la carretera se mantuvo altamente flexible durante varias semanas sin que se deforme. Una vez que se seco, el camino conservo su forma original y continuó soportando cargas pesadas dentro y fuera de la fosa. En varios períodos de fuertes lluvias el camino fue sumergido parcialmente y el tráfico de camiones y remolques no lo echaron a perder. No mantenimiento ha sido llevado a cabo durante un período de 9 meses y la calzada no muestra ningún signo de deformación o desgaste significativo.

Loudens Lane

Loudens lane is a medium trafficked unsealed road with low commercial traffic values. The road consists of several steep hairpin curves subject to rapid corrugation in dry periods and scouring in wet periods. The purpose was to PolyCom stabilise insitu material in order to minimise maintenance frequencies and reduce degradation the existing pavement increasing re-sheeting intervals. Material is a quartz/granite and crushed river gravel type with a PI of approximately 7. The treated area was 1000m x 5m @ 100mm deep.

PolyCom requirement was determined to be 24kg in total with 84,000 litres to obtain OMC therefore a mix ratio of 1kg to 3500 litres of water was required at 0 moisture content. As moisture content was 2% 60,000 litres at a mix ratio of 2500:1 was used to obtain OMC.

Works methodology was to tyne area to 100mm, add PolyCom through the watercart, blade mix to ensure consistency, shape and roll to desired compaction. As seen in prior photos.

The grading schedule was 4 times per year with actual being up to 9. The grading frequency has reduced to 2 per year with the pavement achieving a tight mosaic finish.



Figure 6 Hairpin prepared with polymer



Figure 7 Surface after 2 months of wet periods



Figure 8 Surface after summer dry period, some loose fines but tight mosaic under fines

Dargo Road

The Dargo road is an alpine road subject to snow for 3 months of the year with intermittent snowfalls and heavy rains throughout the year as well as extended temperatures over 40 degrees. It has short periods of high traffic due to ecco-tourism, hunting seasons, logging and 4X4 trekking.

The purpose was to PolyCom stabilise insitu material in order to minimise maintenance frequencies and reduce degradation of the existing pavement from freeze thaw effects, water scouring and pavement saturation in snow thaw. Material is a mixture of basalt sheet rock and granite gravel with areas of high organic content and variable PI.

Each section was 300m x 5 m X100mm deep.

The Polycom requirement was 6kgs with 21000 litres of water a 3500:1 mix ratio.

At time of treatment insitu moisture was 3% requiring 6kgs Polycom with 12000 litres @ 2000:1 mix ratio.to obtain OMC.

The methodology as shown previously was to rip to 100mm depth water in the polymer via water cart and compact with a 12t steel drum roller.

Results

After the snow cover thawed from 2 ! months snow the areas of treated pavement showed no water damage and the pavement was contact and has not absorbed the slow melting snow. In the steep areas there was no rutting or erosion caused by running water and the organic (black) areas had the same density to that of the more granular pavement areas.

Areas not treated have an unravelled surface where the treated areas retained a mosaic surface.

Several months after the snow melt a heavy rainfall (up to 150mm in alpine areas with snow) occurred. The treated areas showed no issues where untreated areas had scoured and rutted with some isolated wet patches. Potholing in runs was caused through loss of shape and water remaining on the pavement with traffic.



Figure 9 Surface after snow thaw, some loose fines over a tight surface



Figure 10 Corner prone to water scouring, no effect after treatment.



Figure 11 dense pavement normally prone to "softies" shows tracks from initial works 3 months previous.

Después de 2 meses y medio que la capa de nieve fue descongelada, las áreas de pavimento tratada con PolyCom no mostró daño de agua y el pavimento no ha absorbido la nieve que se derritió lentamente. En las zonas escarpadas no hubo deformación por la erosión causada por el agua y las áreas orgánicas (negro) tenían la misma densidad que la de las áreas de pavimento más granulares.

Las áreas no tratadas con PolyCom tienen una superficie de desecho y las áreas tratadas mantuvieron una superficie de mosaico (fuerte y densa).

Varios meses después de el derretimiento de la nieve, una lluvia pesada (hasta 150 mm en las zonas alpinas de nieve) se produjo. Las áreas tratadas no mostraron problemas y las áreas no tratadas estaban llenas de baches y con algunos huecos húmedos aislados. Espeleología (Potholing) fue causada por la pérdida de la forma del camino y el estancamiento de agua que quedo sobre el pavimento y por el tráfico.

Bibliography

PolyCom

Appendix

Test results on a "pure granite" from the BHP tunnel

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California Bearing Ratio

Report No: CBR:ALBU07S-03935

Issue No: 1

This report replaces all previous issues of report no 'CBR:ALBU07S-03935'.

Client: Alpine Shire
Great Alpine Road
Bright VIC 3741

Principal:

Job No: LABTALBU00227AA

Project: Bogong High Planes Road Project

Lot No: TRN:



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Approved Signatory: Stuart Kelaher
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 15/11/2007

Sample Details

Product: Terra Firmer Treated

Source: Proposed 20mm Crushed Rock

Location: Bogong, VIC

Client Ref: 0005

Date Sampled:

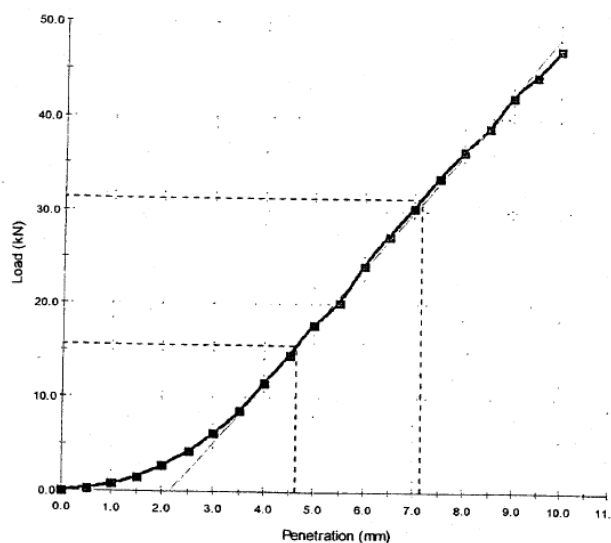
Sampling Method: AS1289.1.2.1 Clause 6.2

Sample ID: ALBU07S-03935

Test Results

| Description | Result |
|--|---------------|
| Test Method | AS 1289.6.1.1 |
| Maximum Dry Density (t/m ³) | 2.210 |
| Optimum Moisture Content (%) | 6.1 |
| CBR 2.5mm (%) | 120 |
| CBR 5.0mm (%) | 160 |
| Preparation | Soaked |
| Initial Moisture Content (%) | 5.5 |
| Achieved Dry Density (t/m ³) | 2.215 |
| Achieved Moisture Content (%) | 5.5 |
| Swell (%) | 0.0 |
| Moisture After Penetration (%) | 6.0 |
| Period of Soaking (days) | 4 |
| Moisture Content of Top 30mm (%) | 6.2 |
| Moisture of Penetrated End (%) | |
| Compaction Type | Modified |
| Surcharge Mass (kg) | 4.50 |
| Laboratory Moisture Ratio After Compaction (%) | 90 |
| Laboratory Density Ratio After Compaction (%) | 100 |
| Oversize Material Excluded | YES |
| Percent Oversize Excluded | 1.2 |

Chart



CBR (%): 160

Rate of Penetration 1.0

Comments

NOTE TO TEST: Sample was dried to constant mass before testing. A 3500:1 mix of Terra Firmer POLYCOM was used as replacement to water for compaction and CBR Testing.

coffey**geotechnics**

SPECIALISTS MANAGING THE EARTH

Albury LaboratoryCoffey Geotechnics Pty Ltd
ABN 93 056 929 483
1/314 Kiewa Street
Albury NSW 2640Telephone: +61 2 6023 3799
Facsimile: +61 2 6023 3644**California Bearing Ratio****Report No: CBR:ALBU07S-03934****Issue No: 1**

This report replaces all previous issues of report no 'CBR:ALBU07S-03934'.

Client: Alpine Shire
Great Alpine Road
Bright VIC 3741

Principal:

Job No: LABTALBU00227AA

Project: Bogong High Planes Road Project

Lot No: TRN:



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Approved Signatory: Stuart Kelaher
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 15/11/2007**Sample Details**

Product: Untreated

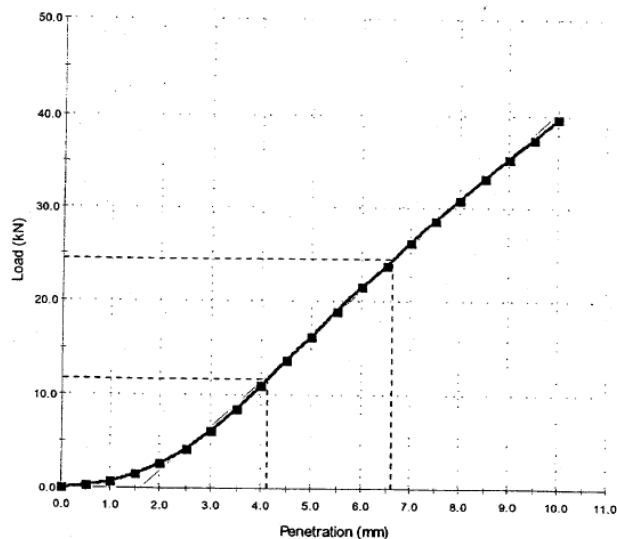
Source: Proposed 20mm Crushed Rock

Location: Bogong, VIC

Client Ref: 0004

Date Sampled:**Sampling Method:** AS1289.1.2.1 Clause 6.2**Sample ID:** ALBU07S-03934**Test Results**

| Description | Result |
|--|---------------|
| Test Method | AS 1289.6.1.1 |
| Maximum Dry Density (t/m ³) | 2.200 |
| Optimum Moisture Content (%) | 6.3 |
| CBR 2.5mm (%) | 90 |
| CBR 5.0mm (%) | 120 |
| Preparation | Soaked |
| Initial Moisture Content (%) | 6.3 |
| Achieved Dry Density (t/m ³) | 4.557 |
| Achieved Moisture Content (%) | 6.3 |
| Swell (%) | 0.0 |
| Moisture After Penetration (%) | 5.9 |
| Period of Soaking (days) | 4 |
| Moisture Content of Top 30mm (%) | 7.3 |
| Moisture of Penetrated End (%) | |
| Compaction Type | modified |
| Surcharge Mass (kg) | 4.50 |
| Laboratory Moisture Ratio After Compaction (%) | 100 |
| Laboratory Density Ratio After Compaction (%) | 207 |
| Oversize Material Excluded | YES |
| Percent Oversize Excluded | 1.5 |

Chart**CBR (%): 120****Rate of Penetration** 1.0**Comments**

N/A