
ANNEX 19

PROGRAM TO IMPROVE EXISTING ROADS

1. INTRODUCTION

An inspection was conducted to the routes, G-25 from Yeso Bridge to El Volcán and Route G-455 from the crossing of Route G-25 to the Embalse El Yeso as to verify the feasibility of using it for the Alto Maipo Project and determine, if necessary, which additional works were needed as to improve the current conditions.

Geometric conditions were verified, plan view and vertical sections, roads, bridges, and works of art. Included also were safety conditions, signaling, and road protection fences.

Special attention was given to sections in Route G-25 where currently watering using bischofite is being used. Additionally and taking the opportunity of the visit, part of the access road currently used by minera La Perla between section Alfalfal – Confluencia Olivares Colorado was also included. In general it be indicated that the effectiveness of the product to reduce dust emissions was verified.

With regard to Route G-25 one conclusion is that the first 12 Km. are in regular conditions and that the two sections in slope show poorer conditions. However this section should be included in future pavement works considered by the MOP. There is no granular cobble mat from Pk 13.8 to Pk 20, but there is a blading of drifting material made of cobble.

While Route G-455 does not have a graded granular cobble road as specified, the current condition allows a safe traffic as no oversize hindering traffic was found. Three sewers were detected needing an extension which consists of 4m slabs that limit the width of the road to 3.5m.

The greater problem found in this route are two sections that suffered sliding of material due their slopes, even produced by the wind.

2. IMPROVEMENT PROGRAM

As these are high mountain roads where environment is very aggressive there are border situations where design would not allow any opposition; however, to keep the roads in normal conditions during winter time and thawing the following works are proposed as minimum. It should also be considered that these roads can freeze in winter.

2.1 ROAD EL VOLCÁN, ROUTE G-25

- Replace granular cobble road $CBR \geq 60\%$ from Pk 13.8-Pk 20 for a 7m width and 15cm thick.
- Laying out of road signs from Km. 12 to km 23.3; a total of 50 signs and 60 vertical delineators are estimated.
- Placement of road fenders in curves without visibility and risk of falling for vehicles from a great height, from km 12 to km 23.3. (A total of 200m is estimated)
- An engineering structure, a $d=0.80\text{m}$ diameter corrugated tube, in the area where mat will be replaced, approx. at Km. 20
- Annual watering using bischofite¹ with dust suppression effect: one watering per season to all the length of the road (23Km) including the section to be paved by the MOP.

2.2 CAMINO YESO, ROUTE G-455

- Placement of road signs in the whole road is estimated in 100 signs total and 50 vertical delineations.
- Placement of road fenders in curves without visibility and risk of falling for vehicles from a great height, from km. 10 to km 19. (A total of 200m is estimated.)
- Engineering structures, $d=0.80\text{m}$ diameter corrugated tube, in the area, approx. at km 6 where a loading station for water trucks is located.
- Replace granular cobble road $CBR > 60\%$ from Pk 17.8 to Pk 18.3 for a 7m width and 15cm thick.
- Construction of two dips in rock, section Pk 18
- Build masonry wall lower than 1m high to separate the edge and contain spillages as to allow manual clearing and/or with equipment. In sections 40m in Pk 3.6, 80m Pk 4.2 and 300m from Pk 17.8 to Pk 18.8.
- Increase size of three concrete boxes for sewage of 4 to 7m.
- Annual watering with dust suppression effect bischofite; one watering run per season is estimated for all the length of the road (22Km.)

¹ There are a number of technical studies conducted to determine the efficiency level in controlling dust on the roads using watering with a solution with bischofite. The works conducted include the Study "Comparative Analysis of Dust suppression Efficiency by using Dustmate equipment and the Economic effect for Frequent and Regular Conservation of Granular Mats developed by the Road Agency from Maule Region from November 2005 to July 2006 (see Annex 4). The main findings from that Study include that watering using a solution with bischofite reduced emissions generated in at least 93%; this effect is produced not only by increasing surface humidity in the road by watering but also because bischofite allows a greater compacting and bonding between the fine particles in the surface. Other studies of this kind were conducted by Salmag Ltda. (Company supplying Magnesium Chloride Hexahydrate) commissioned by the Road Agency for the VIII and VI regions (see Appendices 2 and 3 in Annex 4).

REPORT OF CONDITION OF ROUTES G-25 AND G-455

1. CAMINO VOLCAN, ROUTE G-25

The inspection starts from Puente El Yeso where asphalt pavement ends; this bridge is 35m long with sidewalk of 7m and in good conditions.

A 6 to 7m wide granular road starts after the bridge. This section coincides with the hill with an estimated slope of 10%, which along with the deficiencies in the sub-grade material shows surface waving (deep) which makes traffic of trucks difficult.



Image 1 Hill section of the road with surface treatment failed due to traction on slope and poor quality of sub-grade.

Road signs and fenders are scarce and/or are in bad conditions which are very important during the construction phase, particularly in Pk 20.3 to 23.3 where the road has a narrower platform.



Image 2 Section in hill, backward view.

Below is the route both in plan view and vertical section with the appropriate geometric conditions. The mat is regular conditions and in some sections with houses adjacent a surface treatment with bischofite has been applied.



Image 3 Section with dust suppression treatment.



Image 4 Section with failure in dust suppression treatment failed due to water on the mat.

Water enters without control to the road and early destroys the surface treatment with bischofite.

Pk 4.3 Puente Volcán is 25m long and has a 7m boardwalk; it is in good conditions and is a recent construction.



Image 5 Puente Volcán.

Both road route and elevation have appropriate geometric conditions. The mat is in average conditions and the criteria of applying bischofite in areas that have seldom houses adjacent to the road is kept. Generally the road until Pk 8 runs through a narrow valley located between the range of mountains and Volcán River.



Image 6 Section without dust suppression



Image 7 Section with bischofite treatment due to houses adjacent to the road.

From Pk 8 onwards the road is closer to the effect of high summits.

In Pk 8.7 the action of cobble with drifting material produces contamination on the mat; this situation is common until Pk 12.



Image 8 Road with cobble mat due to cobble transferring material to the road platform.

Pk 13.8 to 20 near the crushing plant Volcán, the road has a scarce presence of the mat; what is present results from drifting of coarse material from the action of cobble crossing the road.



Image 9 Representative section of Pk 13.8-Pk 20, drifting material in sidewalk.



Image 10 Pk 16.8 Drip in construction uses natural rock; MOP work.



Image 11 Pk 20 Plan view of El Volcán crushing plant and view of route to Baños Colina.

From Pk 20.3-Pk 23.3 the road runs in open cut through the hills of ejection cones lying on the mountain mass. The width of the board varies from 4 to 5m with scarce possibilities of widening; the cobble mat seems in good conditions with an application of bischofite all along the section. There are isolated sections of 3m wide concrete pavement in regular conditions. There is a constant traffic of trucks with 12m³ bins from the mine to the Plant at Pk 20.

Bridge over Colina ravine, with metal beams and wooden planks of 20m long. It seems to be in good conditions.

2. ROAD TO EMBALSE YESO, ROUTE G-455

The start of the route is at the crossroad with Route G-25 with an elevation of 1300m.a.s.l. with semi-urban characteristics; the first 700m of the road crosses the industrial facilities of the gypsum plant El Romeral.



Image Y-1Pk 0.0 Planta Industrial Romeral. Route G-455 crosses the facilities of the plant.

The first 700m of the road have a cobble mat 6m wide have coarse granulometry and is in regular conditions.



Image Y-2 Pk 0.0 Route G-455, forward view.

The first 5Km. of the route run separated from El Yeso River at an approximate distance of 50 to 100m; the route and the vertical elevation are appropriate and no severe failures affecting the traffic is detected. As a general note, some minor sewage may be missing of the corrugated tube type of $d=0.8\text{m}$ mainly to drain lower points, minor side dips, etc.

The main problem with this section is related to two areas that have permanent activity which translates in a constant dragging of material which reaches the road. This situation occurs in Pk 3.6 and 4.2; in the latter the volume of material falling needs to be removed using larger machinery.



Image Y-3 Pk 4.2 Plan view, ejectment cone active with drifting material on board.



Image Y-4 Pk 3.6 and 4.2 Backward view, ejection cones active with drifting material on board.



Image Y-5 Pk 4.2 Material constantly falling on the board.

With regard to the cobble mat it shows conditions appropriate for traffic; it can be observed that surface-wise is natural, that is, not produced in plant and maintenance is done with profiling and sand dressing by removing the oversize.



Image -6 Pk 9.3 4m narrow slab reduces the width of the board to 3m.



Image Y-7 Pk 9.3 Plan view.

It is possible to see in Image Y-8 the geometry of the road; there currently is a permanent traffic of trucks hauling material to Romeral plant located in Pk 0.0. Initially it should not have any obstacles for the transportation of material and equipment.



Image Y-8 Pk 10.5 to 12.5 is the section with greater restriction in plan view and vertical elevation. Pk 12 road in cobble.



Image Y-9, Pk 12 road in cobble.



Image -10 Pk 14.7, a 4m narrow slab reduces the width of the board to 3m.

From Pk 17.8 to Pk 18.6 approx., a section of the road runs with its platform excavated in a cut; the hill's angle is near 45° and there is continuous spillage of material; also, a couple of dips are missing as to intersect a number of brooks.



Image Y-11 Pk 17.8 to Pk 18.6 Side excavate in cut, 5 to 6m wide; dips are missing and drifting material on the side.



Image Y-12 Pk 18 Material constantly falling on the board



Image Y-13 Pk 18 Material constantly falling on the side. Forward View.

With regard to the number of trucks, it is expected to have a truck per working area (El Volcán, El Yeso, Alfalfal, Aucayes alto and bajo, and Las Lajas).

When adding the aforementioned with other mitigation measures for atmospheric emissions described under Chapter 6 of EIA and those provided under the Supplementary Study for Emissions, attached in Annex 4, it will be possible to control all those activities generating particle material.

With regard to the use of bischofite for dust suppression, it is important to highlight that this product by itself does not generate problems maneuvering or with drivers safety as confirmed with the experience applying this product in areas with significant rates of annual rainfall.

Based on recommendation of magnesium chloride suppliers, in order to avoid any type of situations where the product responds inefficiently, PHAM has adopted the following measures:

- Control of the application as to avoid overdosing or reduction of the dosage in extremely plastic soils.
- Cleaning or clearing of snow or rocks from the road as to provide free traffic of the vehicles.
- Appropriate maintenance of sanitation works.
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