

## Approval & Reception Procedure

CA – Coordenação E Assessoria	
<b>Summary of Quality Control of Ka-Hó Tunnel (excavation, anchors, drainage, shotcrete, steel structure and waterproofing layer works)</b>	Document No. <b>ARP/CA/02</b>
	Rev. No. <b>A</b>
	Date : <b>2013-08-28</b>
	Page No. <b>1 of 3</b>

According to the Technical Specifications and BQ, basically there are the following works:

### Excavation:

*Method:* Smooth blasting / excavation machinery method.

The contractor must submit the excavation general plan before starting the work, as well as the support system according to the geological characteristics of the rock.

This work must comply with ASTM standards.

General requirement for environment protection under blasting.

During the excavation works for the tunnel, contractor must install a monitoring system according to BQ items C2, including C2.1 to C2.11.

### Drainage system:

1. Tunnel interior and entrances North and South:

*Material:*

Perforated PVC drain pipes and reinforced concrete U channels with D400 cast iron covers: should comply with design drawings, technical specifications and B.Q.

Diameter, location and installation of drain pipes should follow details on design drawings.

2. Slope:

*Material:*

HDPE perforated pipes: diameters, length, location and installation should follow design drawings or indicated by designer.

Minimum pipe thickness > 4.5mm;

HDPE pipes density > 0.941g/cm<sup>3</sup> (ASTM D1505);

Pipe strength > 20 MPa (ASTM-D4595);

Pipe elongation >350% (ASTM-D4595).

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	Page No. <b>2 of 3</b>

### Anchor for rock/ slope:

#### Material:

1. Anchor bolts: at least 20cm long, should comply with BS449 Grade 460/ ASTM 615-78 with D25-D29/ Thread re-bars SD42.
2. Bearing plate: should comply with BS4360 GRADE 43A or design drawings.
3. Nuts: should comply with BS4190 or ASTM A307.
4. Cement: should comply with BS12/BS1370/BS4027.
5. Transient junction agent: should be submitted the information of manufacturer and test report. Chloride content should not over 1%.

#### Test:

Frequency: 1% anchor bolts should be tested (pull out test);

Tensile pull out capacity: 12t or above for normal anchor bolts;

6t or above for pre-stress anchor bolts.

### Shotcrete:

1. Shotcrete thickness should be according to support structure for excavation class (I, II, III e IV) mentioned in design drawings and B.Q..
2. Should be obtained 2cm protection cover for all steel elements.

#### Test:

40m<sup>3</sup> or 500m<sup>2</sup> shotcrete should be selected 1 group of testing sample (cylinder/cubes);

The compressive strength: Cylinder: 3days  $\geq 160\text{Kgf/cm}^2$ , 28 days  $\geq 200\text{Kgf/cm}^2$

Cubes: 3 days  $\geq 200\text{kgf/cm}^2$ , 28 days  $\geq 250\text{kgf/cm}^2$

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	Page No. <b>3 of 3</b>

### Steel structure:

1. Steel elements should comply with ASTM A36 or ASTM A572 GR. 50
2. Bolts should comply with ASTM A307
3. Nuts should comply with ASTM A194
4. Rust protection of steel pieces to be painted should comply with SIS-05-5900 Sa2 ½ or SSPC-SP-10.
5. Galvanized protection must comply with BS5493
6. Painting system should comply with BS5493 (primer) and BS5493 (epoxy coating and finish)
7. Thin plates of stainless steel should comply with ASTM A240 type 304 and stainless steel pipes should comply with ASTM A 276 type 304.

### Waterproofing layer:

1. Non-woven geotextile and waterproofing membrane
2. Test result should be complied with table 1 to 3 in chapter 07 of technical specifications.

The contractor must obey to Technical Specifications, B.Q., Topographic surveying and good practices of engineering works.