Geotechnical statement of Rio Santa Lucia bridge foundations

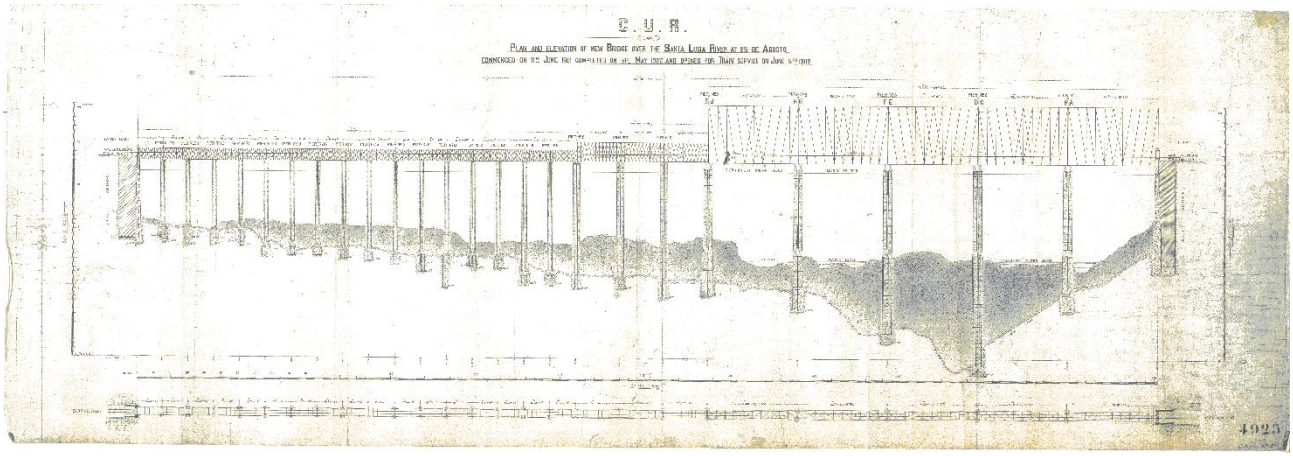
The meaning and the content of the Geotechnical Statement

The statement in the pre-engineering phase based on the available information gathered from different sources. In this phase, the goal has been to give the statement upon available information and to point out the to the uncertainties to the detailed design phase and to define next steps in the investigations. The pre-engineering has experience based estimation including:

- Gathering of available drawings and information of possible soil investigations
- Evaluation of visual inspection data
- Geotechnical evaluation, including
  - reliability of available information
  - estimate of soil and foundation types
  - estimate of possible damages and deviations to original situation
  - needed actions in next phase.

General

The Rio Santa Lucia bridge has been opened for train service in 1902. Bridge in built on concrete steel covered column foundations. In old original drawings 1933...1936 there are details of columns "as built". According those drawing columns are founded in hard rock or rock.



There are no damages detected on foundations in visual inspections. Abutments on bridge ends and middle piers are straight. The steel superstructures of the bridge are to be strengthened, by renewal of cross girders and secondary girders. Strengthening and heavier axel loads will increase load to foundations in total under 10 %, when most the loads to the foundations are from the own weight of the steel structures. The basis of design is to keep increase of loads to the foundations as little as possible.

When the foundations are extended to rock layers, usually the capacity of its structural parts of the bridge is determinant. According to the old drawings foundations are on rock but there is not information about the resistance of the rock.

If the rock cannot be classified as hard, also geotechnical capacity should be calculated. To make more accurate evaluations, proper calculation need proper soil and rock parameters. Soil and rock parameters can be defined with soil investigations.

Planned soil investigations

The planned investigations of the next stage include soil investigations for bridges. Drilling is programmed next to each abutment to find out soil and rock circumstances on foundation level and under the foundation level. Investigations are done also next to the abutments located in water.

There will also be underwater surveying to find out if there are damages in abutments itself or if there are water erosion problems in the material near structures.

On the grounds of investigation results should make sure that existing foundations can carry load from repaired bridge. From investigations receives deriving presumed bearing resistances of rock. For example, very weak rock about 0,25MPa. This value is compared to load on ground level of foundation according Eurocode EN 1997-1

Loads to Existing bridge

Main dead loads

The existing bridge has spans of 17*15,24 meters (girders) +3*25,9 meters (Truss) + 5*53,0 meters (Truss). The estimated weights of old bridge spans are as follows:

- Girder span 15,24 meters
  - 1,1 tons / meter = total of 16,8 tons
- Truss span 25,9 meters
  - 3,6 tons / meter =total of 93,2 tons
- Truss span 53,0 meters
  - 4,2 tons / meter = of 222,6 tons

The wooden sleepers and the rails add to the weight of the bridges approximately 0,4 tons / meter.

The weight of the columns, which are of steel and filled with concrete (filling material is unconfirmed) is about 20 tons/column meter.

Traffic loads

The Traffic Load used in the designs to old structures is LM71-22,5. The old load model to the bridges is 18 ton axles. The load increase to the track and bridges is 25 % in the project scope.

The capacity of older structures must also be evaluated with safety factors. The safety factors must be sufficient as old load models had very moderate safety factors. The design traffic loads may increase more than 25 % due to safety margins.

The Traffic loads need to include vertical loads such as traction, breaking and rail forces, since the new track structure is continues rails.

Other loads

There are no significant changes to other loads.

Other studied options

A possible new 53-meter truss span with new design criteria is estimated to weigh 5,0 – 6,0 tons/meter, which is an increase of 20-40 % compared to the old span. In the shorter spans the increase is 10-25 % compared to the old spans. New spans are recommended to be constructed with a ballast layer, and the total weight of the truss spans with a ballast layer are estimated to be 9-10 tons / meter (90-100 % increase in total dead loads).

A concrete deck with a ballast layer is estimated to be too heavy for old columns and piers. The weight is very dependent on the optimized cross section and possible tensioning of the bridge, but it is estimated to be at least 15 tons/meter (concrete) + 5 tons (ballast and rails) = 20 tons / meter.

These options are estimated to require new foundations.