High pier long span viaduct in highly seismic zone

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High Pier Long Span Viaduct in Highly Seismic Zone

Viaduc de grande portée et sur piles élevées dans une région sismique

Weitgespannte hohe Talbrücke in Starkbebengebiet

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1. INTRODUCTION

In Motorway Projects, deep and wide valleys along the alignment generally have to be crossed by viaducts. In these cases; to select the viaducts' type considering construction time, method of construction and design criteria is seen as an important problem to be solved at the first stage of the study. Considering seismic forces and risk analysis, soil investigations, constructability and serviceability; different construction methods, materials and structural systems are compared on the basis of construction time and costs. In this comparison; Structural, Geotechnical and Constructional aspects are to be carefully studied, but sometimes, these studies may take long time. In this paper, the most important items during viaduct type selection study have been summarized. As a case study, a viaduct still under design has been presented.

2. STRUCTURAL, GEOTECHNICAL AND CONSTRUCTIONAL ASPECTS

The following are checked in detail before selection of the viaduct type:

Structural Aspects : System Selection (dimensions: deck, piers, capping beams, spans), Design Principles (spec.s), Design Methods (Multi-Mode Spectral Dynamic Analysis), Aesthetics, Road Alignment Design...

Geotechnical Aspects: Seismotectonics, Fault Zones, Seismic Risk, Seismic Zones, Engineering Geophysics and Geology, Geomorphology, Geotechnical Investigations (in-situ and laboratory tests), Foundation Types, Piers' and Abutments' Foundations and Stability, Stability of Cuts, Span Verification...

Constructional Aspects: Constructability and Serviceability, Construction Work Schedule, Foundations, Piers (Formwork system, concreting...), Abutments, Material Selection (i.e. corrosion resistant structural steel, high-strength concrete, bearings, joints, ...), Method of Construction (Topography and Access Condition, Temporary Works, Fabrication, Transportation, Assembling, Erection), Equipment, Machinery, Costs...

3. CASE STUDY

Along 260 km Motorway Project between Adana and Gaziantep, the viaducts are planned in the alignment to eliminate tunnels in the mountain area mainly for reducing the construction time. The biggest valley to be crossed by a viaduct has spans 110m long and piers max.150m high. Compherensive studies on the type selection of the viaduct were made mainly because of very strong earthquake effects and limited construction time.

The structural system has been selected from considerations of geological conditions, strong seismic effects and limited construction time. The area contains many faults. Effective bedrock acceleration coefficient has been given as 0,4 g for that region. Soil investigations have been carried out and include in-situ and laboratory tests such as borings, geophysical studies mainly based on electric resistivity and seismic refraction, and time history evaluation considering the records taken in last 100 years. Seismic risk assessment, estimation of the horizontal peak ground acceleration and investigation of the existence of active or capable faults studies were completed in the previous studies before the viaduct type decision. Being located very close to two major tectonic lines, the area of interest strongly fractured and deformed. Taking into account Gutenberg-Richter Law, an earthquake database is used for seismic risk evaluation. The expected horizontal Peak Ground Accelaration for 100 year time period is obtained as 0.4 g at the site area. In order to investigate the near-surface features, seismic refraction, seismic reflection profiling, resistivity sounding and resistivity profiling measurements had been undertaken. Further geotechnical studies in the site are currently being continued.

The most suitable structural system found for the viaduct is a closed steel box-section beams composite with cast-in-situ reinforced concrete deck and reinforced concrete hollow tapered section piers when considering the high seismicity of the area and the important height of the central piers. The structural depth required for the steel single-cell-box girders is about 4.5 m for such an important deck 17.5 m wide. Slenderness (span/depth ration) is approximately 22 which contributes to give a sufficiently aesthetical appearance without disregarding economical and erection aspects. Orthotropic deck system found inappropriate. It would create potential construction and maintenance problems, and would require more precise control in fabrication and assembly. Steel deck beams have been chosen for the 110 m long main spans and will be launched from one abutment. Each deck system shall support a single carriageway. Because of very short construction time, at the west abutment two pushing systems operating separately at the same time for each carriageway are used.

The other types of bridges such as suspended, balanced-centilevered concrete deck, arch... have been compared. Advantages and disadvantages in constructability, timing, contractor's capability, construction techniques, aesthetic aspects, low maintenance and other effects have been compared. As a result, continuously supported-constant depth rectangular steel box-section beam composite concrete deck system and incremental launching method on concrete pier supports at typically 110 m spans has been selected, as shown in Fig. 1 given below,

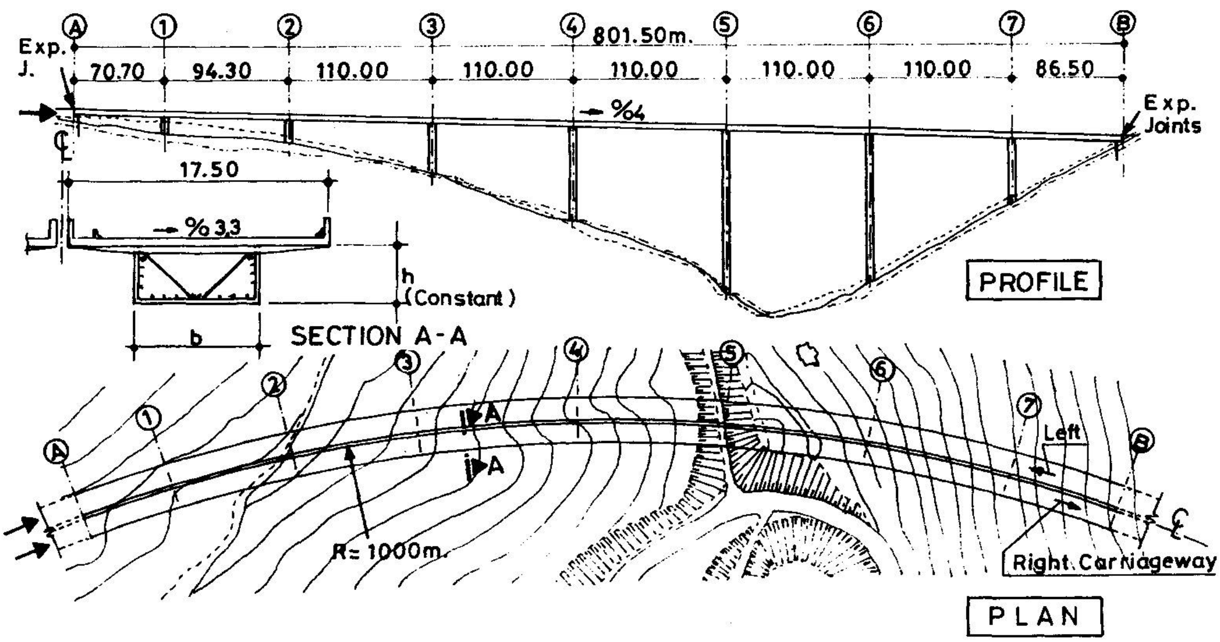

Fig.1 - Plan, Profile and Typical Deck Section of the Viaduct.