ABSTRACT

The present dissertation is a parametric investigation of the antiseismic behaviour of the bridges with precast - prestressed concrete beams and a continuous deck plate.

Those bridges, although they are considered to be inferior to the box-girder bridges in quality (durability, functionality, aesthetics), they have many advantages which establish them competitive to the box-girder bridges. They are more economic and their construction is not time-consuming. In the case of a vale bridge with high piers the box-girder bridges take to expensive solutions, like cast in place balanced cantilevers and propulsion, as opposed to the bridges with the precast concrete beams which give an easier solution with the use of cranes which is more economical.

The starting point-bridge is an Egnatia Street bridge Technical Work T6 in the position 17+468,00 to 17+678,00 of the section Asprobalta – Strymonas. This bridge was in our disposal in a preliminary stage, which was designed with Sofistic. The technical characteristics and the geometry of the bridge were transcribed to SAP 2000 in the given form and then we experimented analytically.

The bridge has a total length of 208m with 6 spans, the two terminally spans of 34m and the rest of them 35m each.

Each span of the bridge has 4 precast – prestressed concrete beams per traffic lane, a deck plate which is comprised of precast plates that are placed on the beams as also cast in situ concrete layer.

Between the head of each pier and the prestressed concrete beams elastomeric steel reinforced bearings are placed, while stoppers are placed in the transversal direction.

The bearings provide independence of movement to the superstructure and the piers, as also to the longitudinal direction, while stoppers provide the same displacements for the head of the piers and the superstructure to the transverse direction of the bridge. The deck of the bridge is continuous, while expansion joints are placed only over the abutments in order to undertake the contraction's or the expansion's displacements and a part of the seismic displacements. The continuity of the deck over the piers is provided by conjunctive plates.

The bridge was analyzed with SAP 2000 edition NL7.44.

In the 7th chapter, the simulation of the geometry of the bridge is made with linear (frame) and shell elements. The specified loads for the bridges were applied based on DIN 1072 and the seismic loads were defined with the design spectrum of EAK 2000, according to the instructions of E39/99. The definition of the masses and the materials follows. Finally, the cross-sections are defined.

All the elastomeric bearings have been checked to strength and stability and also we checked the most critical abutmen.

The above approach is the common base for the design of a bridge. Parameterization of the present dissertation starts with the investigation of the different parameters, which are considered to be more interesting. Briefly the parameters which were investigated are the four parameters below. The parameters were combined together and resulted to more than 60 different interpretations of solutions and a plethora of comparative graphics, which picturize the seismic loading of the piers for the longitudinal and the transversal direction of the earthquake.

Based on the above simulation of the starting point-bridge with the 6 spans, models with 3 or 12 spans were simulated. The height of the piers, referring to the bridge with the 3 spans, was considered to be the same to the height of the terminal piers of the 6-span bridge, while the height of the central piers, referring to the 12-span bridge, was the same to the height of the central pier of the 6-span bridge.

Specifically, the 12-span bridge was investigated under two different interpretations (a) with continuous deck (b) with n expansion joint over the central pier.

The second parameter that was investigated, after the number of the spans, was the height of the elastomeric bearings. Three different cases were investigated with 90,120,160mm height of bearings. The fourth case, concerning the height of the elastomeric bearings, that was investigated for the 12-span bridges with continuous deck, is the case referring to the scaled height of the bearings 160mm over the abutments 120mm to the three terminal piers and 90mm to the of rest piers. This scaling of the height of the bearings is considered to be compatible to the functional needs of the bridge and the a rational distribution of the seismic loads to the piers, which have the same cross-section but different height.

Finally, the third parameter that was investigated was the effect of the decrement of the stiffness of the piers and the deck, which are often under cracking (Stage II). The effect of cracking is not usually being considered to the estimation of the response of this kind of bridges.

Over 60 analysis of bridges were done based on the elastic or the inelastic (modified elastic) spectrum, for the seismic zone II, behaviour factor q=1 and importance factor γ_I=1,30. The longitudinal forces are undertaken by elastomeric bearings exclusively, and the transversal forces are undertaken by seismically effective stoppers.