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DESIGN OF PRETENSION PRESTRESSED CONCRETE GIRDER BRIDGE FOR CAMBODIAN REHABILITATION

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ABSTRACT: For rehabilitation of bridge in Cambodia after civil war, it is necessary to choose a type of structure which is cheap, fast to build and durable. The precast prestressed concrete structure has been the choice of technology because the concrete structure needs less maintenance compared with other types of structure, the use of prestressing technology can save materials and the precast system can shorten the construction time even in adverse weather the progress of construction can be assisted. However there are still no original design manuals for pretension prestressed concrete bridge suitable for Cambodia. Therefore the design of precast prestressed concrete girder has been done to satisfy the requirements of Cambodian situation for now and for future such as the conditions of transporting and moving the girders for construction with the considerations of traffic load, climate and equipment. Self-compacting concrete which needs no vibration and gives high strength is used to satisfy the design conditions, to improve the construction process of precasting and to improve the durability of concrete structure. The objective of this study is to determine the precast prestressed concrete girder for the span of 20 meters. The design method of pretension prestressed concrete girder bridge and the determination of precast prestressed concrete girder are presented. The study shows the benefit of precast prestressed concrete girder using self-compacting concrete for Cambodian rehabilitation.

KEYWORDS: Cambodian rehabilitation, Bridge, Pretension prestressed concrete girder, Self-compacting concrete.

1. INTRODUCTION

Until now, most bridge in Cambodia has been constructed in the conventional reinforced concrete structure with multi short spans of about 5 meters of each span. Because of its technical and economic benefits, pretension precast system has become as traditional method for bridge construction in many countries over the world. But this technology is still new for Cambodia. This paper presents the design of pretension prestressed concrete girder bridge for Cambodian rehabilitation. Three main steps were considered in the design: production of precast girder, transportation and construction step. The design was made to satisfy the conditions of the equipment for moving the girders for construction, access road to the construction site, weight limit for transportation and climate. The weight of precast girder is limited differently for the present time and for future. The most suitable precast girder for Cambodia is determined by the conditions of self-weight of girder and total cost of bridge superstructure. High strength concrete is used to decrease the weight of girder. Among high strength concretes, self-compacting concrete (SCC) gives most advantage. With this type of concrete, thinner section can be chosen for design. So SCC is used to satisfy the design and the placing concrete condition for selected shape of girder. The possibility of self-compacting concrete using the available materials on the market in Cambodia had been studied [5].

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2. DESIGN METHOD

The weight of precast girder is limited at 12 tons for the present time due to transportation condition. Low weight of precast girder can be determined by the combination of the following considerations:

- Shape of section
- High strength of concrete
- High prestressing force
- Number of girders
- Debonded materials: the prestressing force can be applied at largest eccentricity.

To determine the shape of girder, the calculation was made for typical one lane bridge as shown in Figure 1. Dimensions of T-shape and box shape girders are chosen as in Figure 2. The height of girder depends on the length of span. The calculation was done for the span of 10, 15, 20 and 25 meters and for three cases of design concrete strength: 45MPa, 60MPa and 75MPa. The traffic load (load type A) given in Japanese standard for bridge design is used. Creep and shrinkage models given in CEB-FIP90 are used to predict the loss of prestress caused by climate effect. Temperature of 28°C and relative humidity of 70% are considered as the climate condition in Cambodia.

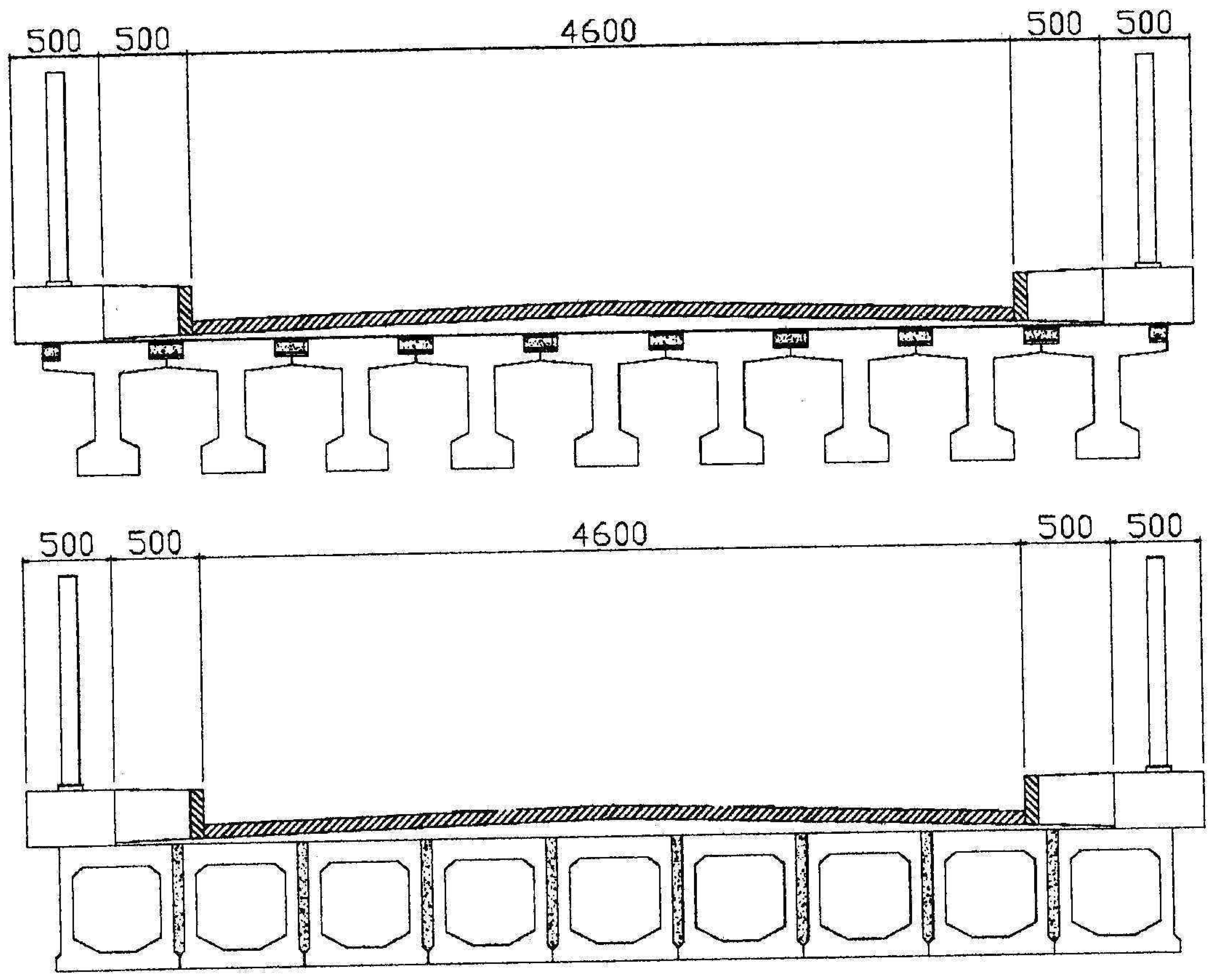

Figure 1. Typical one lane bridge of T-shape and box shape girders

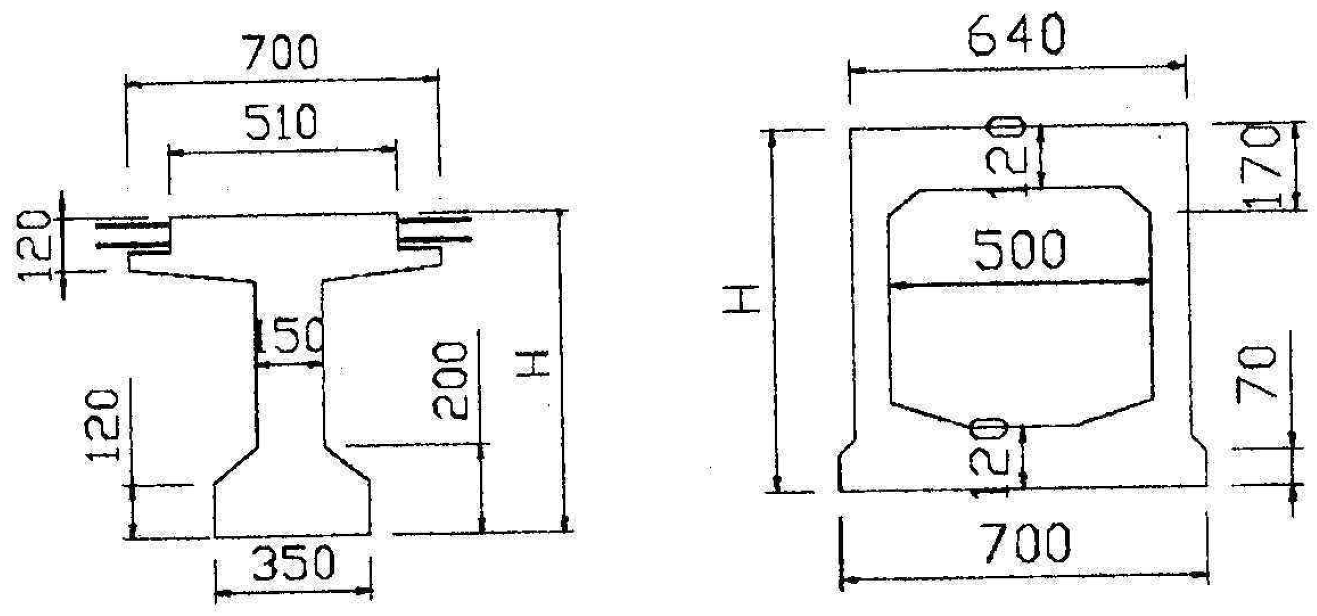

Figure 2. Dimensions of T-shape and box shape girders

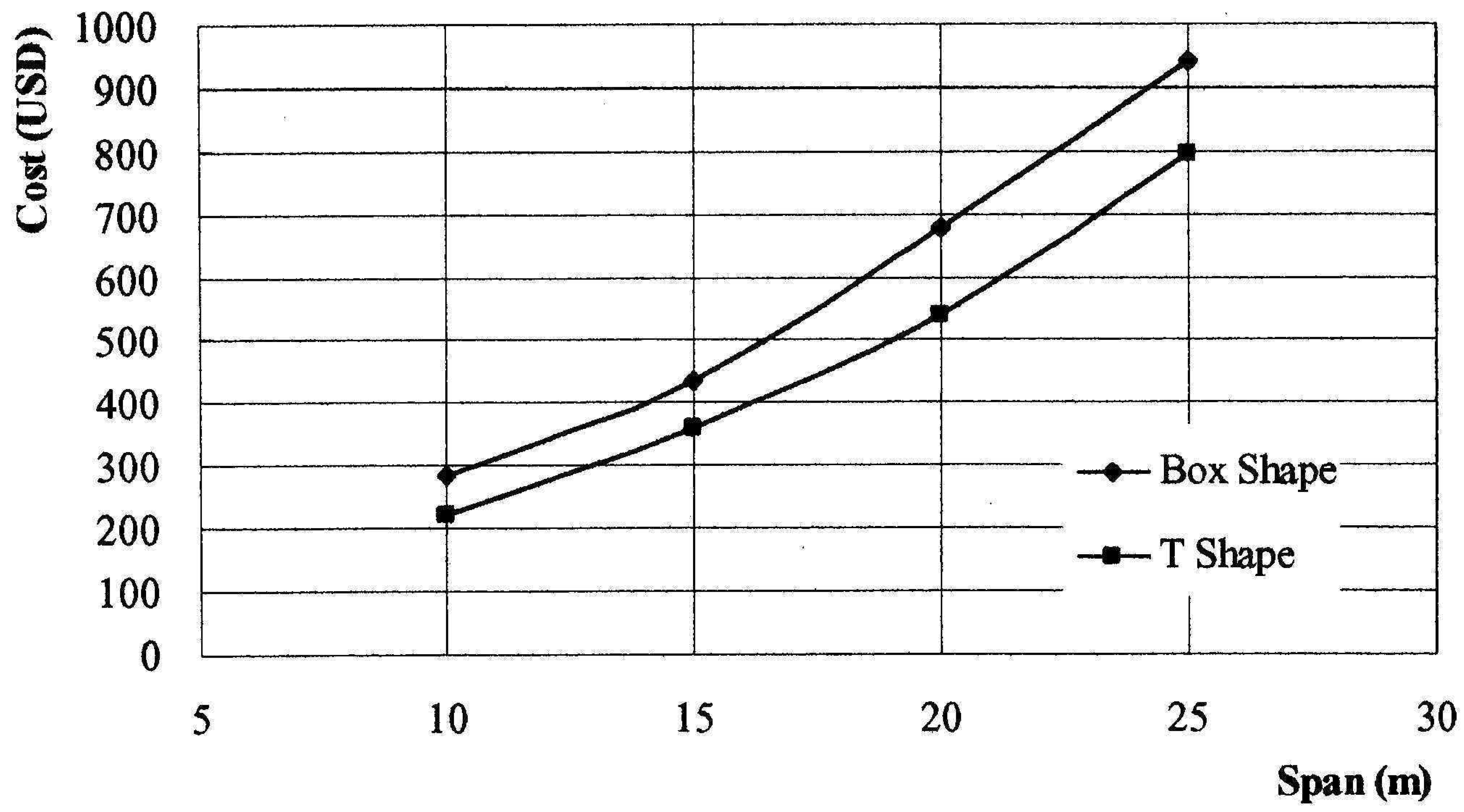

Figure 3. Material cost of girders for the case of concrete strength 60MPa

Only the cost of concrete and PC strands is taken into account for the material cost shown in the graphic of Figure 3. And it can be seen that T-shape girder needs less materials compared with box shape. The same results are obtained for cases of design concrete strength of 45MPa and 75MPa. So T-shape girder is selected.

Then typical two lanes girder bridges of T-shape and T-shape with heavy bottom flange of 20 meters of span with one intermediate diaphragm as shown in Figure 4 and Figure 5 were designed by:

- Vary the number of girders from 14 to 8 girders in term of the change of top flange width
- Vary the height of girders in 5 cm of step from 75cm to 120 cm
- Vary the design strength of concrete: 40MPa, 60MPa and 80MPa
- Consider with the case of bond control.

The traffic load type B given in Japanese standard for bridge design is used. The calculation was verified at precast, at service and at ultimate limit states. The PC strands used for calculation are 15.24mm of nominal diameter, 1860MPa of ultimate strength and low relaxation.

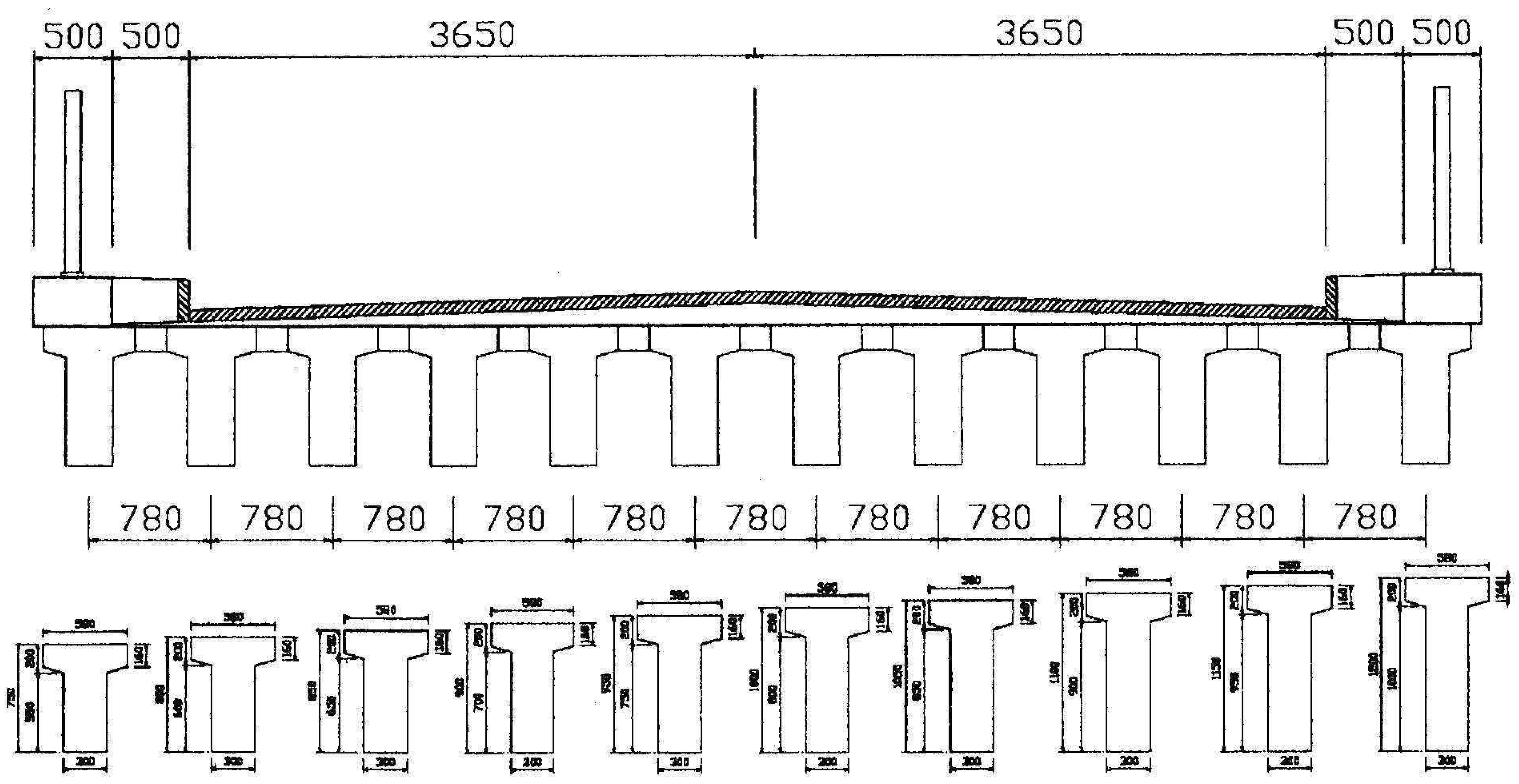

Figure 4. Typical two lanes girder bridge of T-shape

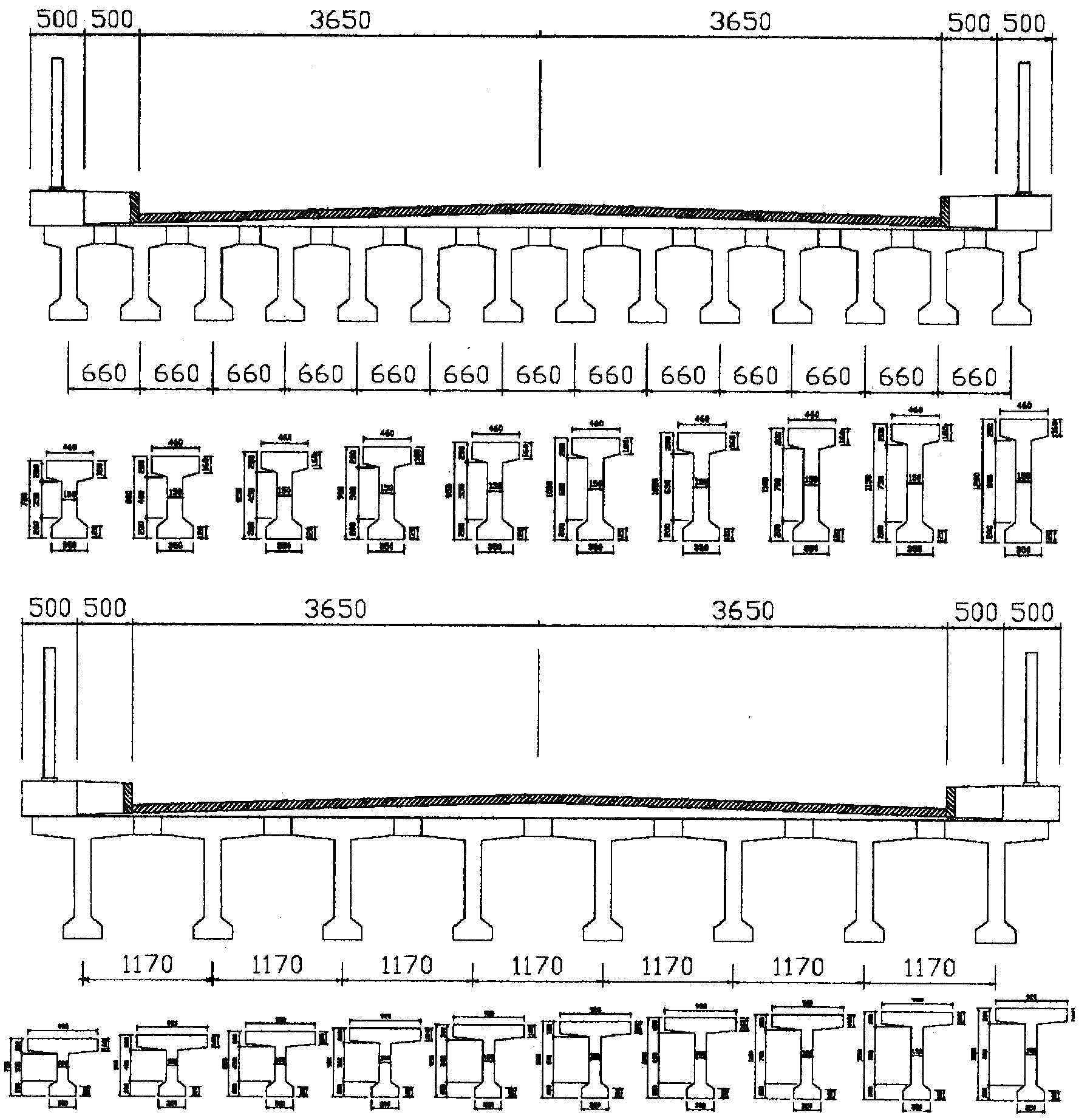

Figure 5. Typical two lanes girder bridge of T-shape with heavy bottom flange

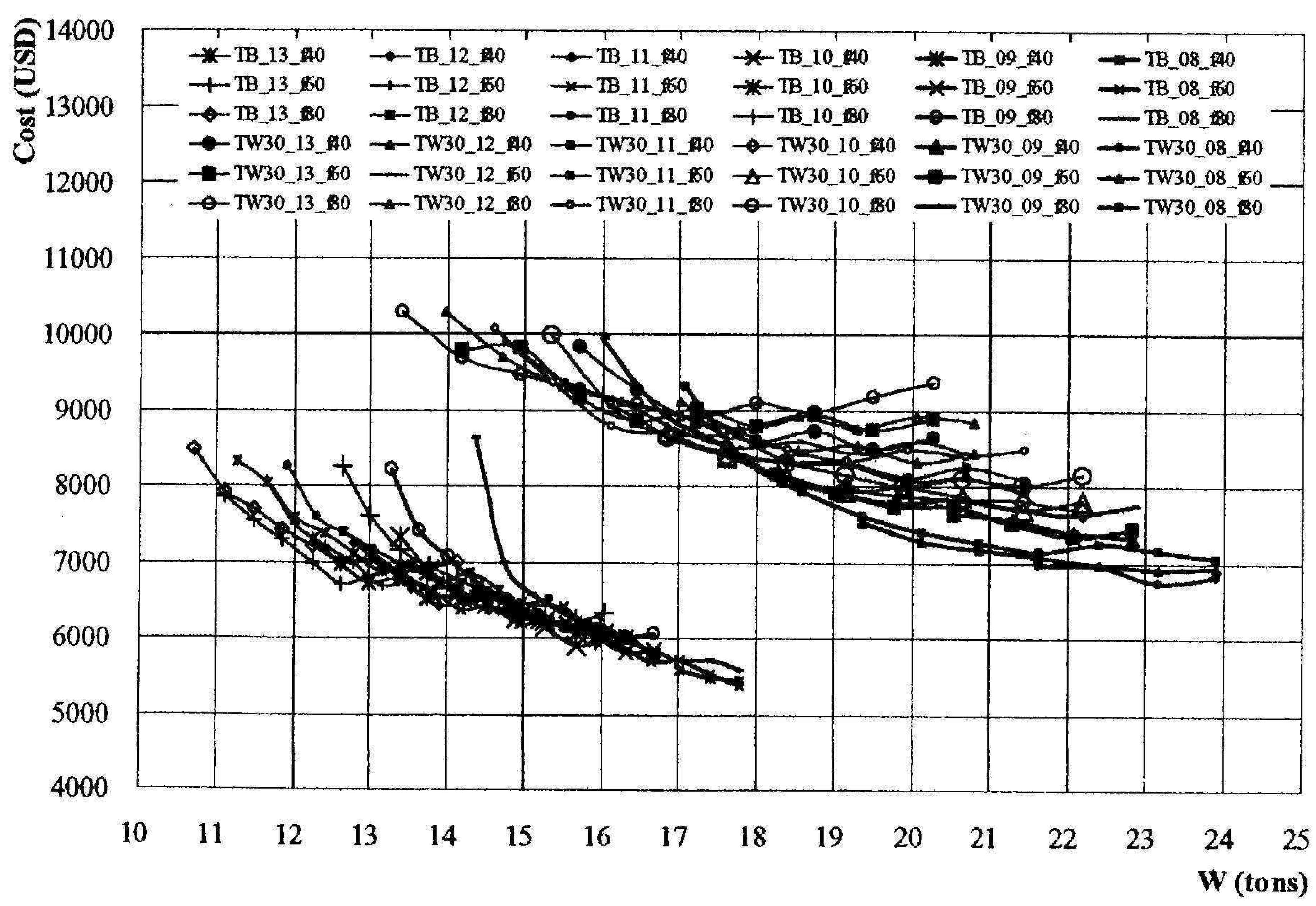

Figure 6. Material cost of bridge superstructure

The results are represented on the graphic of Figure 6. Symbol used in graphic: TW30 means T-shape girder with 30cm of web, TB means T-shape with heavy bottom flange girder, the number in the middle part represents the number of girders for the two lanes girder bridge and the final part represents the design strength of concrete. For example: TW30_12_f60 means T-shape girder with 12 girders for two lanes girder bridge and design strength of concrete = 60MPa. Based on this graphic T-shape with heavy bottom flange is selected.

3. SELECTION OF GIRDER

The total cost of bridge superstructure is calculated for each case. The selection of girder was made by the conditions of transportation and economic. With the limitation of its self-weight, the precast PC girder can be selected by using the graphic shown in Figure 7. For the case of the limitation of the self-weight at 12 tons, the girder of TB_12_f60 with 85 cm of height is selected. The dimensions of selected girder are shown in Figure 8.

For the selected girder, the total prestressing force just after transfer is 2000kN and its eccentricity is 402.2mm. Bond control is required.

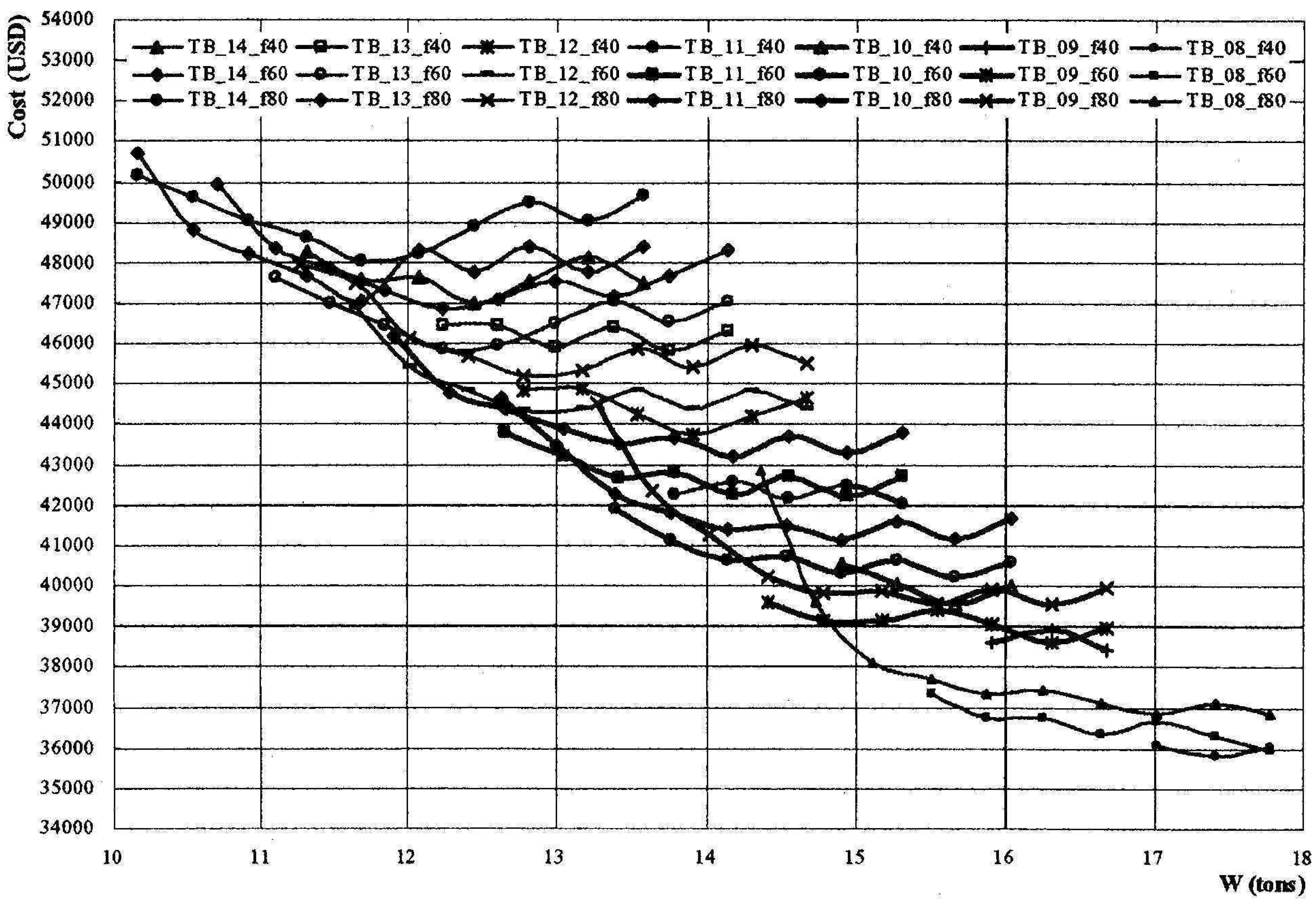

Figure 7. Total cost of bridge superstructure

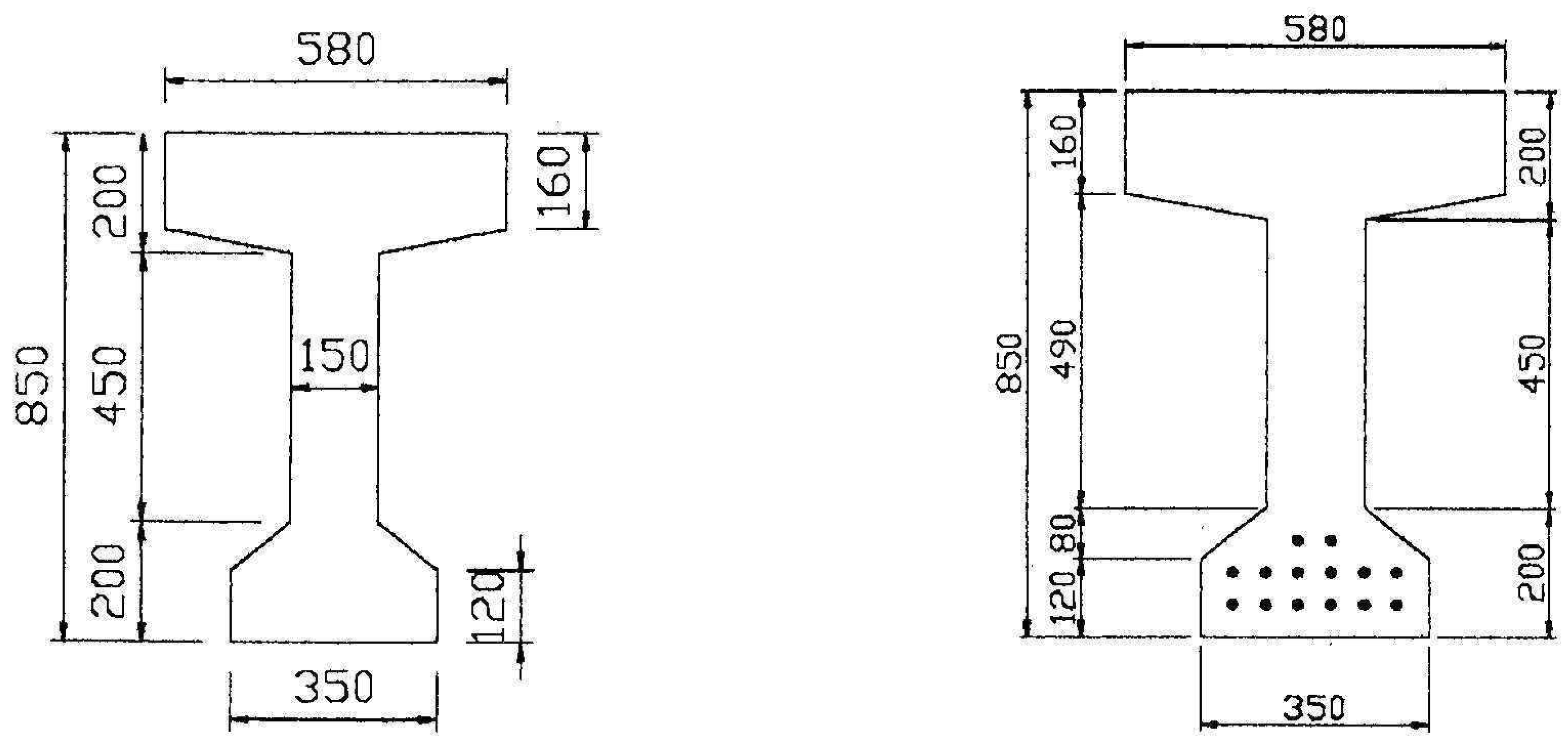

Figure 8. Selected girders

4. CONCLUSIONS

1) Low weight girder can be produced to satisfy the requirements of Cambodian situation at the present time by the combination of:

- Using T-shape with heavy bottom flange girder
- Using high strength concrete
- Applying high prestressing force
- Increasing the number of girders
- Using debonded materials

2) When the transportation condition is better (heavier girder can be transported), girder bridge can be constructed with lower cost.

5. REFERENCES

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