Design of Pretension Girder Bridges for Cambodian Rehabilitation

Graduate student, Kochi University of Technology JSCE student member ○ Vong Seng
Professor, Kochi University of Technology JSCE member Hiroshi Shima

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. 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. As precast prestressed concrete system can save the materials and the construction time even which in adverse weather the progress of construction can be assisted and it can improve the quality of final product with less maintenance, it has been the choice of technology. 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.

2. Design method

Self-weight of girder is limited at 12tons for the transportation condition in Cambodia at the present time. To satisfy this condition and economical condition, the design was made by the method as follows:

- Determine the shape of section
- Use high strength of concrete and apply high prestressing force
- Increase number of girders
- Consider the case of bond control: eccentricity of the prestressing force is situated as highest as possible.

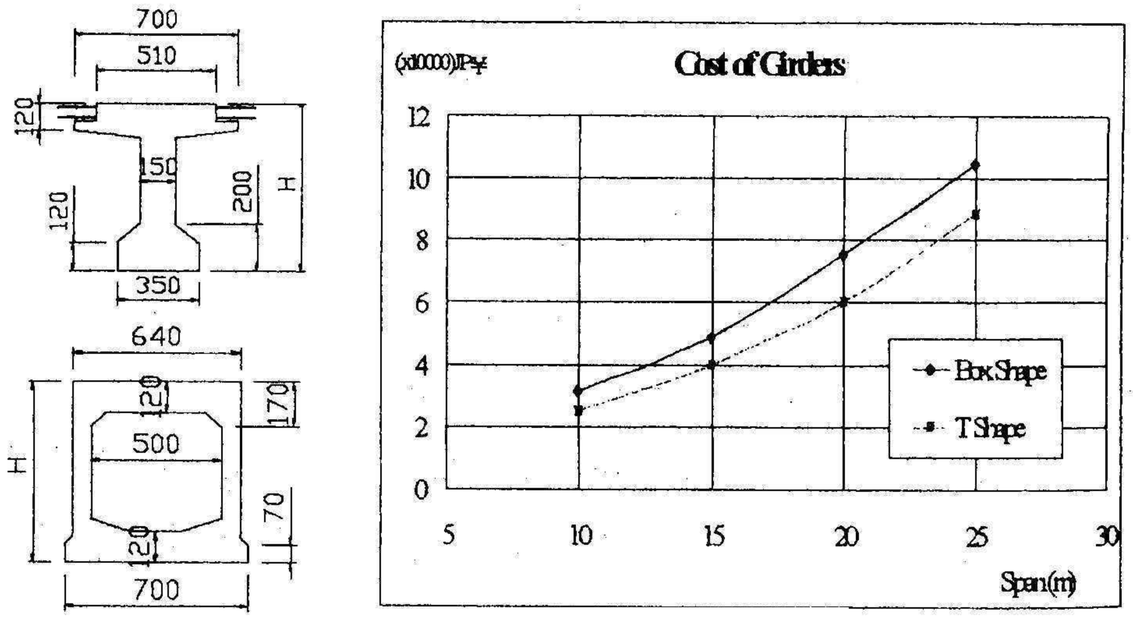

Fig1. Shape of section

Traffic load (load type B) given in Japanese standard for bridge design is used for calculation. 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.

Based on calculation as shown in Fig1, T-shape with heavy bottom flange was selected (in Fig1: cost of girders represented on ordinate are included only the cost of concrete and PC strands)

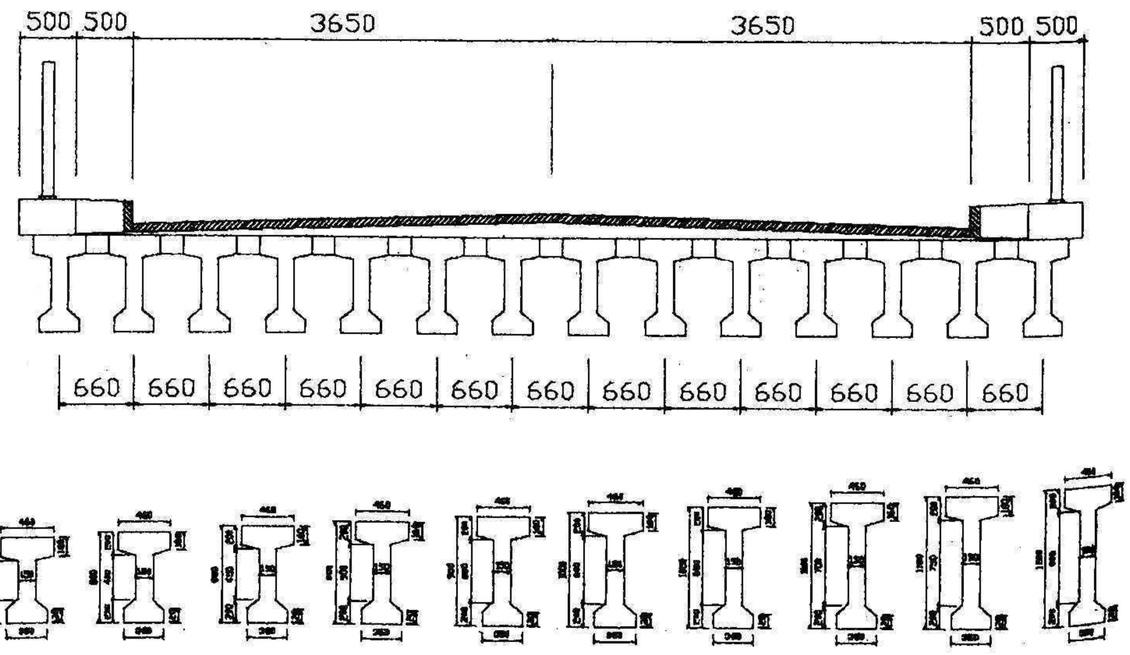

Fig2. Bridge with 14 girders

Keywords: Girder bridge, pretension, precast girder, Cambodian rehabilitation
Contact address: Department of Infrastructure Systems Engineering, Kochi University of Technology
185 Miyanokuchi, Tosayamada-cho, Kami-gun, Kochi 782-8502

Two lanes girder bridges of T-shape with 20 meters of span and one intermediate diaphragm as shown in Fig2 were designed by:

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

Self-compacting concrete is used to satisfy the design condition 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 (4).

3. Selection of girder

The total cost of bridge super structure is calculated for each case. The selection of girder was made by the condition of transportation and economical condition. With the limitation of its self-weight, the precast PC girder can be determined by the graphic shown in Fig3 For the case of the limitation of its self-weight at 12 tons, the girder of TB_12_f60 (TB: Tee beam, 12: number of girders, f60: concrete strength=60MPa) with 85 cm of height is selected. The dimensions of selected girder are shown in Fig4.

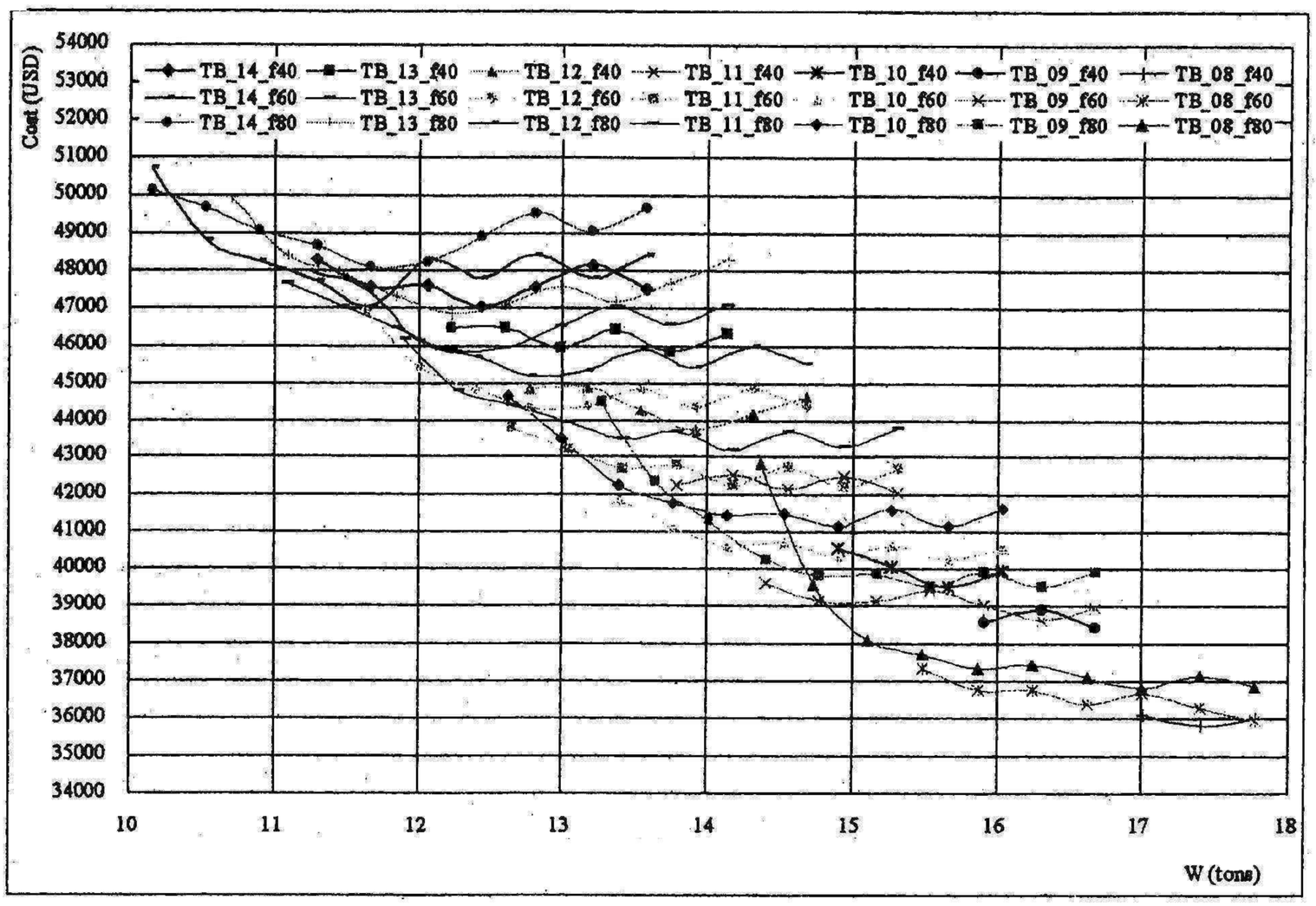

Fig3. The total cost of bridge super structures

The calculation was verified at precast, at service and at ultimate limit states. The PC strands used are 15.24mm of nominal diameter, 1860MPa of ultimate strength and low relaxation. The total prestressing force just after transfer is 2000kN and its eccentricity is 402.2mm. Bond control is required.

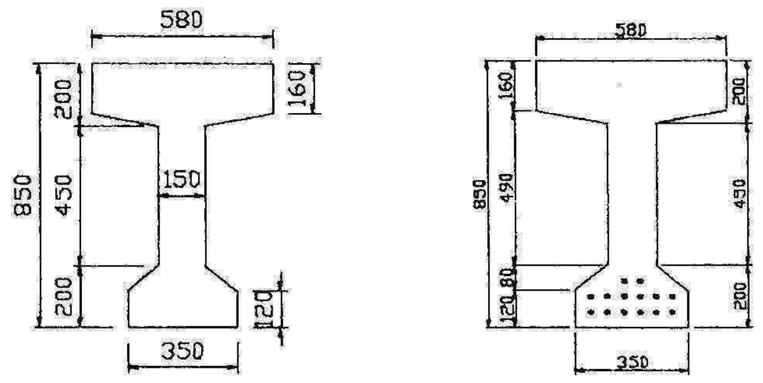

Fig4. Section of selected girders

4. Conclusions

1) The following requirements are needed to satisfy the situation condition in Cambodia at the present time:
   - High strength concrete
   - High prestressing force
   - Increasing number of girder
   - Bond control
2) When the transportation condition is better (heavy girder can be transported), girder bridge can be constructed with lower cost.

References

1). JSCE, 'Standard specifications for concrete structure-2002'- March, 2002

2). JSCE, 'Recommendation for Self-Compacting Concrete', August 1999

3). Oversea road note 9, 'a design manual for small bridge'- Transport Research Laboratory 2000

4). V. Seng, H. Shima, M. Ouchi, 'Possibility of self-compacting concrete in Cambodia'- Proceeding of- Proceeding of International Conference on Concrete Technology in Developing Countries, Kuala Lumpur, 2004