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EFFECTIVE WIDTH OF EDGE BEAM GIRDER SUBJECTED TO BENDING MOMENT AND AXIAL FORCE

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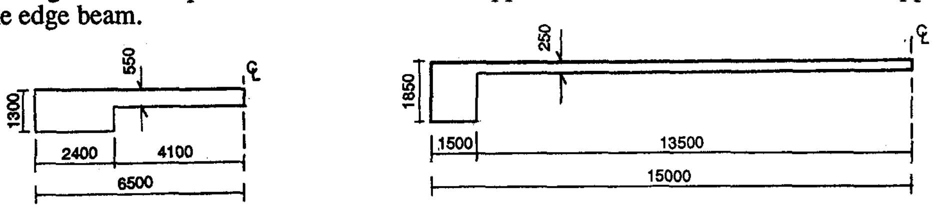
1. Introduction: Edge beam girder is frequently used for cable-stayed bridge. The main structural component of the edge beam girder consists of edge beam, slab, and diaphragm. In cable-stayed bridge the girder must withstand not only bending moment due to external loads but also axial force due to cable force or internal prestressing force. The regulation stipulates effective width equal to span/8 for one side beam subjected to bending moment. The present study investigates effective width of edge beam girder subjected to both moment and axial forces simultaneously and emphasizes on longitudinal behavior of edge beam. The influence of diaphragms to the beam effective width is also investigated.

2. Analytical Method: Finite element program ABAQUS is used to calculate load-displacement relationship of girders. The geometrical and material nonlinearities are considered in the analyses. The longitudinal deflection curve of edge beam is assumed as series of polynomials and the curvature of the edge beam can be computed as second derivation of its deflection curve. Since moment and beam curvature are known, the effective width of the edge beam can be computed.

3. Analytical Model: Two typical sections of edge beam girders, as shown in Fig. 1, are examined. The numerical analyses are carried out for girders on simply supported subjected to uniformly distributed load with uniformly axial prestressing force equal to 30 kgf/cm^2. Because the girders and loading are symmetry, only one quarter of the girder is meshed. Finite element mesh is shown in Fig. 2. The displacement constraints are applied between nodes at lower and upper parts of the edge beam.



(a) Section 1 of Edge Beam Girder (b) Section 2 of Edge Beam Girder
Fig. 1 - Typical Sections of Edge Beam Girder

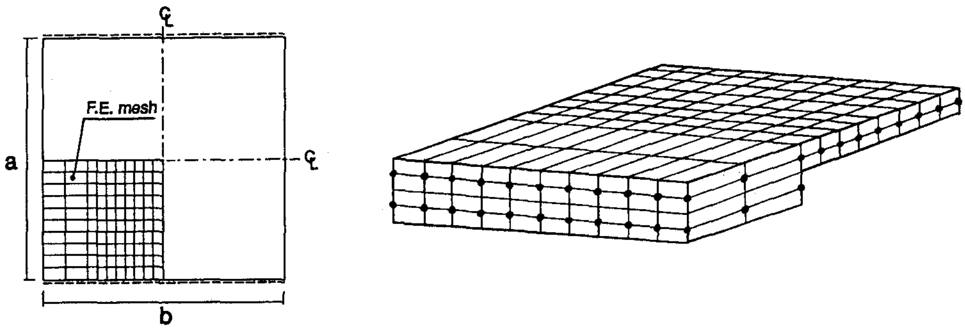


Fig. 2 - Analytical Model of Edge Beam Girder

For both sections two span-width ratios a/b=1 and a/b=5 are studied. Although it is impractical to adapt Section 2 without diaphragms, that case is also analyzed for comparison purpose. The influences of diaphragms to the effective width are also investigated. Elastic diaphragms are attached at both sections.

<u>4. Analytical Results</u>: The moment-curvature relationships and moment-effective width relationships of Section 1 are shown in Fig. 3 and Fig. 4, respectively. For case a/b=5 the effective width, as expected, covers almost overall flange width. For case a/b=1 larger effective width values are obtained than design regulation value. No significant contribution of diaphragms in longitudinal flexural behavior is noticed.

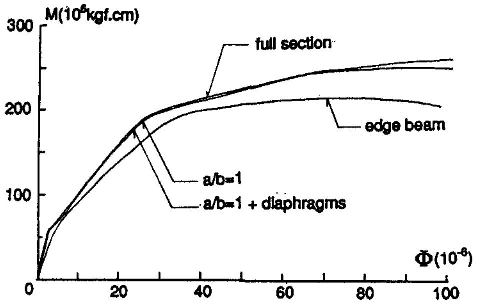


Fig. 3 - Moment vs. Curvature of Section 1

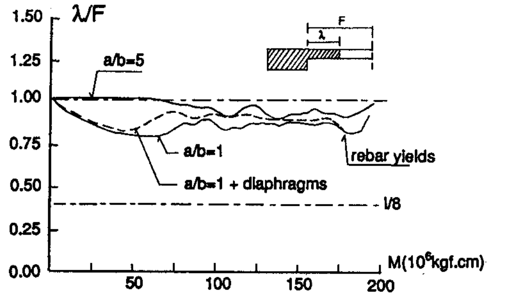


Fig. 4 - Moment vs. Effective Width of Section 1

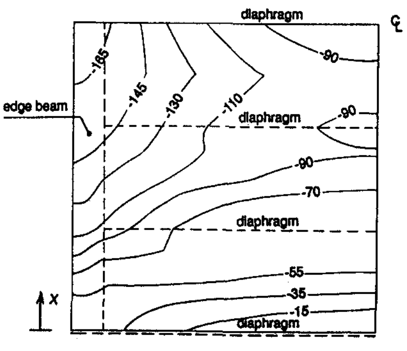


Fig. 5 - Stress at Upper Fiber of Section 2

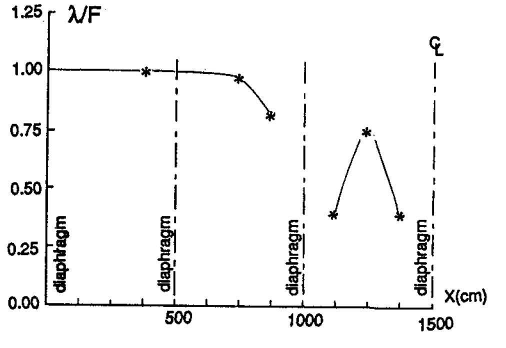


Fig. 6 - Effective Width of Section 2

The compression longitudinal stress contour at upper fiber of Section 2 with diaphragms is shown in Fig. 5. The stress concentrations occur at joint nodes between edge beam and diaphragms while the stress is more widely spread out at location between two diaphragms. Consequently effective width of edge beam varies along longitudinal axis as shown in Fig. 6. The moment-effective width relationships of Section 2 are shown in Fig. 7. A significant progress in effective width for Section 2 with diaphragms is noticed.

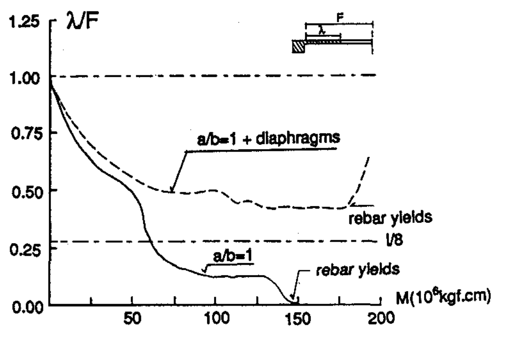


Fig. 7 - Moment vs. Effective Width of Section 2

<u>5. Conclusions</u>: The following conclusions have been drawn from this study:
1. Design specification provides a conservative design for edge beam girder subjected to both moment and axial forces.
2. Diaphragms improve longitudinal flexural behavior of edge beam in Section 2.

<u>6. Future Works</u>: Further study should be carried out for edge beam girder as two-way slab system. A ratification of effective width estimation method as a total system of cable-stayed bridge should be considered.