An Optimization of Girder Bridges to Condense the Overall Costs

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Abstract: Girder bridges are broadly used bridge system for brief to medium span (20m to 50m) highway bridges because of its moderate self weight, structural efficiency, easy fabrication, low maintenance etc. To be able to contend with steel bridge systems, the style of I-girder Bridge system must result in the most cost effective utilization of materials. Within this paper, cost optimization approach of the publish-tensioned PC I-girder bridge product is presented. The aim would be to minimize the all inclusive costs within the design procedure for the bridge system thinking about the price of materials, fabrication and installation. For the girder span and bridge width, the look variables considered for that cost minimization from the bridge system, are girder spacing, various mix sectional size of the girder, quantity of strands per tendon, quantity of tendons, tendons configuration, slab thickness and ordinary reinforcement for deck slab and girder. Design constraints for that optimization are thought based on AASHTO Standard Specifications. The optimization issue is characterized by getting a mix of continuous, discrete and integer teams of design variables and multiple local minima. An optimization formula known as Transformative Operation (EVOP) can be used, that is capable of doing locating directly rich in probability the worldwide minimum. The suggested cost optimization approach is in contrast to a current project which results in a substantial cost saving while leading to achievable design.

Keywords: Girder Bridge Cost Effective; Evolutionary Operation;

I. INTRODUCTION

The most typical kind of plate girder is definitely an I-formed section developed from two flange plates and something web plate. As soon as-fighting off capacities of plate girders lay approximately individuals of deep standard folded wide-flange shapes and individuals of trusses. Plate girders could be welded riveted, or screwed. Riveted plate girders are practically obsolete. Very couple of screwed plate girders is made nowadays. Therefore, we only cover the style of welded plate girders. Plate girders are utilized both in structures and bridges. In structures, when large column-free spaces are created to be utilized as a set up hall, for instance, home plate girder is frequently the cost-effective solution. In such instances, the designer must choose from a plate girder along with a truss. Plate girders, generally, possess the benefits below over trusses [1]. Connections are less crucial for plate girders compared to trusses, particularly statically determinate trusses. Inside a statically determinate truss, one poor connection could cause the collapse from the truss. In comparison, plate girders generally weigh more than trusses, specifically for very lengthy spans. Plate girders essentially carry the masses by bending. The bending moment is mainly transported by flange plates. To be able to lessen the girder weight and perhaps achieve maximum economy, hybrid plate girders are occasionally used. Inside a hybrid girder, flange plates are constructed with greater-strength steel compared to the net. Or, inside a tee-built-up plate girder, as proven in Fig. 9.4, the T sections are constructed with greater-strength steel compared to connecting web plate. Style of hybrid plate girders can also be covered within this chapter. Allowable bending stress for hybrid girders is restricted to .60Fy.

II. PLATE GIRDER BRIDGES

Plate girders grew to become famous the late 1800's, once they were utilized in construction of railroad bridges. The plates were became a member of together using angles and rivets to acquire plate girders of preferred size. By 1950's welded plate girders replaced riveted and screwed plate girders in planet because of their higher quality, appearance and economy. Using plate girders instead of folded beam sections for those two primary girders provides the designer freedom to decide on the most cost effective girder for that structure. If large embankment fills are needed within the methods to the bridge, to be able to adhere to the minimum mind-room clearance needed, the half through bridge is much more appropriate. This arrangement is generally utilized in railway bridges in which the maximum allowable approach gradient forth track is low. Within this situation the restraint to lateral buckling of compression flanges achieved with a moment fighting off U-frame composed of floor beam and vertical stiffness, that are connected plus a moment fighting off joint. When the construction depth isn't critical, a deck-type bridge is the perfect solution, by which situation the bracings provide restraint to compression flange against lateral buckling. Primary plate girders: The look qualifying criterion for primary girders as utilized in structures was discussed in chapters on Plate Girders. Within the following sections extra aspect that should be considered in the style of plate
girders in bridges, are discussed. Generally, the primary girders require web stiffening to improve efficiency. The functions of those web stiffeners are described within the chapters on plate girders. Sometimes variations of bending moments in primary girders may need variations in flange thickness to acquire economical design [2]. This can be accomplished either by welding additional cover plates or by utilizing thicker flange plate around bigger moment. In very lengthy continuous spans (span> 50 m) variable depth plate girders might be cheaper. Initial style of primary plate girder is usually according to experience or thumb rules for example individuals given below. Such rules also provide a good estimate of dead load from the bridge structure to become designed.

![Fig.1.Distribution reinforcement](image)

### III. PROPORTIONATING OF THE WEB PLATE

Additionally to flange plates along with a web plate, a plate girder frequently includes intermediate and bearing stiffeners. As pointed out in the last section, the 2 flange plates essentially carry the bending moment. An internet plate is required to unify the 2 flange plates and also to carry the shear. Thin web plates are inclined to unstable behavior. Thick web plates result in the girder unnecessarily heavy. A comparatively thin web plate strengthened by stiffeners frequently yields the lightest plate girder. Stiffened plate girders are made based on the best strength concept. Because the magnitude from the strain on the girder is elevated, the net panels between adjacent vertical stiffeners buckle because of diagonal compression caused by shear. For any theoretical presentation from the subject the readers should make reference to Salmon and Manley. For that designer of plate girders the detailed understanding from the theoretical development isn’t essential. She/he should, however, acquire an understanding of the behavior of plate girders under growing load. When the plate girder has correctly designed stiffeners, the instability from the web plate panels, bounded on every side through the transverse stiffeners of flanges, won’t lead to its failure. It’ll then have the ability to carry additional loads. A stiffened plate girder has considerable publish buckling strength. The publish buckling strength from the web plate might be 3 or 4 occasions its initial buckling strength. Consequently, designs based on tension-field action can yield better economy. Hybrid girders can’t be designed based on tension-field action, because of the insufficient experiment results.

### IV. WELDED CONNECTIONS

Flange and web plates are linked to one another by fillet welds. Figure 9.12 shows a disassembled area of the plate girder between two neighboring sections. Flange-to-web fillet welds are made to transmit horizontal shear because of the variation from the bending moment within the girder and also the direct pressure because of applied distributed load. The designer must range from the framing plan and camber diagram for every span, saline sketches, within the plans. Finished deck elevations are proven within the plans, in the centerline of bearing over each abutment and pier line, and also at 1/tenth points or at10 foot. Times, whichever is less: Transversely over each beam longitudinally across the span in the break points within the mix slope from the deck. Approach and transition slabs are needed for those bridges around the DDOT Highway System. The finish from the approach slab will be parallel towards the skew. The width comes from fascia to fascia from the bridge. The finish of approach slab should rest on the sleeper slab to avoid motionless excessively. The excavation for that sleeper slab will be made following the compacted abutment backfill is positioned. The sleeper slab will be founded on undisturbed compacted material. No loose backfill will be used. Approach slabs shall continually be another pour in the superstructure slab and put on an aggregate base. Generally, fill placed behind abutments settles following the bridge is opened up to traffic. Because of this, the Department's policy would be to construct reinforced concrete approach slabs to span the fill area [3]. The approach slab will be designed like a structural slab the least 15-in.thickness that's supported each and every finish. Their lengths shall change from no less than 20 foot. To some maximum that is dependent on the intercept of the one on one line from the foot of the abutment excavation to the foot of the approach slab. The slab will be created for nearest towards the following span length. This length will be measured across the centerline of roadway. Unless of course precluded by profile and geometric factors, the median area between parallel bridges will be “decked over” once the width between curb lines is 30 foot. Or fewer. Once the median width is more than 30 foot., cost estimates will be designed for the choice of “decking over” versus. “Open well design”. Decking over is preferred in every case for safety reasons once the extra construction price is relatively minor [4]. Live load the perception of the median area shall be also HS20 25 % (HS25).D.C. Give a ¼ in. open deflection joints in parapets at times not exceeding 20ft. Contraction joints in the midpoint between your open joints shall be also provided. Contraction joints will
be provided in sidewalks in the locations from the 1/4 in. open parapet deflection joints. Give a ¼ in. open deflection joints in median barriers at times not exceeding 15 foot. There will be no contraction joints between your open joints with no contraction joints located underneath the open deflection joints. Full depth joints will be provided in parapets, median barriers and pavement sitting locations of transverse Expansion and glued deck joints. The entire depth joint opening width shall equal the transverse deck joint opening width. All reinforcing steel in parapets, median barriers and sidewalks will be corrosion protected, for example, epoxy coated or galvanized. Longitudinal joints in bridge decks might be needed for very wide bridges, widened bridges or stage-built bridges. Longitudinal joints will always be placed between beams or girders. Put them within the median, if at all possible. Avoid placing longitudinal joints within the wheel road to vehicles or travel-way due to the hazard to motorcycles. Compression seals aren't employed for longitudinal joints. The designer must determine the quantity of joint movement, both transverse and vertical, when making longitudinal strip seals. Longitudinal construction joints shall simply be provided where essential for stage construction as well as for compatibility using the deck slab flowing sequence on wide structures with lots of lanes, or where essential to accommodate transverse expansion on wide structures. Construction joints, either transverse or longitudinal, are allowed only allocations proven around the plans. A building joint can be used in the break between flows, for example individuals needed through the flowing sequence. Normally, construction joints are keyed, cold joints. Bridge designs must permit movements because of temperature. Both steel and concrete structures expand and contract due to temperature changes. Make reference to Section 3.16, Thermal Forces, within the AASHTO Standard Specs for Highway Bridges. Use moderate climate temperature range for that District area. Joints are built in bridges to support movement (rotation expansion and contraction). All joints should be sealed to avoid leakage water to the bearings and substructure. Acquiring a water tight bridge joint is really a difficult objective within the existence of the bridge. Efforts should beam to lessen the amount of deck joints around the bridge. Transverse Joints at fixed bearings are made to accommodate movements from the span because of rotation from the bearing brought on by the loading. Transverse Joints at expansion bearings are made to accommodate expansion and contraction movements from the span brought on by temperature changes and loading. When deciding on strip seals, the designer must think about the relationship between total movements, minimum and maximum joint widths, and installation temperature. Strip seal expansion dams shall contain molded neoprene rubber gland kept in the tooth decay of two parallel steel rail sections [5]. The steel rail material shall comply with AASHTO M 270/M270 M Grade 250 or AASHTO M 270/M270 M Grade 345W. The whole joint system will be hot dipped galvanized after fabrication. Any galvanized coating from the deck joint system that's broken during field welding or using their company causes will be repaired by methods outlined in ASTM A780. Unless of course specified, the galvanized surface shouldn't be colored. If painting is needed, make reference to DDOT standards for guidance in repairing the broken area. The broken area will be repaired just before installing the neoprene gland. The neoprene gland will be continuous forth full bridge width including sidewalks, parapets and median barriers. Strip seal expansion dams are going to be used. The bridge deck drainage system includes all drains on the bridge deckhand the means accustomed to convey water collected. A structural analysis might be needed on all bridge components modified to support the bridge drains. Girder spacing might need to be adjusted or adjust the drain locations because of the closeness of bridge rail posts. The station and offset of every deck drain will be specified by the plans. Drainage from structures shall not drip onto bearings, pier caps, abutment caps or pedestrian walkways. Bridge decks require sufficient grade for correct drainage. This can make sure that chlorides drain from the bridge deck and can prevent pending and freezing water. Additionally, proper drainage prevents hydroplaning on decks with little surface texture. Give a minimum grade of .five percent on bridge decks. When the longitudinal grade is under .five percent, additional drains or special sloping from the gutters might be needed. Sag vertical curves ought to be prevented on bridge decks for hazards from flooding and icing, and aesthetic reasons. To be able to have sufficient longitudinal drainage close to the high reason for vertical curves, the grade shallot is flatter than needed for sight distance needs.

Fig.2. Plate Girder Bridge

V. CONCLUSION

It's concluding the High End concrete has been utilized on highway and railway bridges effectively around the globe due to its natural quality of higher strength, resistant against fracture toughness, weld ability and an excellent resistant against weathering
corrosion. The existence duration of the dwelling is elevated tremendously reducing the price of substructure and foundations and also over all reduced existence cycle costs. Its introduction on Indian National Highways is a excellent decision for that up gradation from the present technology of design, fabrication and upkeep of girder bridges.

VI. REFERENCES


AUTHOR’s PROFILE

RAMAVATH SUNIL NAIK: I completed my B.Tech under JNTUK (KKR&KSR Institute of Engineering & Technology); currently i am pursuing my M.Tech at Chalapathi Institute of Technology under JNTU Kakinada.

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