AN ATTEMPT TO STUDY ON THE DESIGNING OF THE RCC T-BEAM BRIDGE

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ABSTRACT

A bridge is an essential component of any transportation system. Designers typically employ T-beam bridges for short span bridges. The length of bridges ranges from a few metres to many kilometres. They are among the most important buildings ever constructed by man. The requirements for layout and materials are quite stringent. Because of the weight of the people and automobiles who use it, a bridge must be strong enough to support its own weight as well. The form must also withstand a variety of natural phenomena, such as earthquakes, strong winds, and temperature fluctuations. Many bridges feature a concrete, steel, or wood framework as well as an asphalt or concrete path for people and automobiles to travel on. We designed R.C.C T-BEAM Bridge in an appropriate manner in this project. To build a decent design, we used standard code books, standard methods, and past study. The bridge's span is 20 metres, with a clear roadway of 10.5 metres and three lanes. The reinforcement's transparent cover is 40mm thick.

Keywords: Bridge; cross girder; Reinforced Concrete; T-beam

I. INTRODUCTION

Bridges are the lifeblood of the transportation network in both urban and rural areas. The common bridge has been superseded by a creative practical structural system as a result of rapid innovation development. T-Beam and regular Beam are two essential RCC frameworks shown in one of these courses of action.

Bridge design is a goal and, more importantly, a personality-driven approach to structural design. Span length and live loads are constantly essential factors in Bridge design, just as they should be. These elements have an impact on the plan's conceptualization time. The effects of live load are shifting to various degrees. The choice of structural system for a cross is always a variety of possibilities to consider. The structural system has been altered by the creation of pieces such as economy and imagination. The code technique requires us to select a structural system, such as a T-Beam Girder. The outcome influences the choice of a sparing and constructible fundamental framework.

Reinforced concrete is a composite material in which the concrete bears the compressive load and the reinforcement or steel bears the tensile load. Reinforced concrete is particularly suited to the building of medium-span highway bridges. A bridge with reinforced concrete spans and concrete or reinforced-concrete abutments is known as a reinforced concrete bridge. Slab bridges, T-beam bridges, hollow girder bridges, balanced cantilever bridges, rigid frame bridges, arch bridges, and bow string girder bridges are examples of reinforced concrete bridges. The major longitudinal girders of a T-beam bridge are designed as T-beams that are integrated with a portion of the deck slab, which is cast monolithically with the girders.

II. MAJOR COMPONENTS OF T-BEAM BRIDGE

The key components of the RC T-beam superstructure are as follows:

A. Cantilever slab portion

The kerb, handrails, walkway, or crash barriers, if supplied, are carried by the cantilever slab component, which is also a part of the roadway. The vertical section at the intersection of the cantilever part and the end longitudinal girder is the crucial section for bending moment.

B. Intermediate and end cross girders or diaphragms

The main purpose of cross girders is to strengthen the girders and minimise torsion in the outside girders. These are required above the supports to prevent girder lateral spread at the bearings. The cross girders also serve to balance three deflections of girders bearing large loads with those of girders carrying less loads.

C. Deck slab

A bridge's deck slab is the highway or pedestrian walkway surface. A deck slab is a structural component of a bridge's superstructure. Concrete, steel, open grating, or wood can all be used to build the deck. The concrete deck may be a structural component of the bridge (T-beam construction) or supported by I-beams or steel girders.

D. Footpaths

A footpath is a sort of highway designed solely for walkers, with no other types of transportation such as automobiles, bicycles, or horses allowed.

E. Longitudinal girders with a T-section in the design.

When cross girders are not employed, longitudinal girders are provided with straight T-ribs. The rib is made thinner and the bottom of the T-rib is broadened to allow the tensile reinforcing bars when several cross girders are employed.

F. Coat-wearing

A wearing coat is applied to concrete bridge decks to protect the structural concrete from direct traffic wear and to provide the necessary cross camber for surface drainage. The thickness of the wearing coat is kept consistent, and the top of the deck is changed to allow for surface drainage by cross camber.

III. DESIGN

Before a bridge can be built, it must be planned separately. Local terrain, water currents, river ice formation possibilities, wind patterns, earthquake potential, soil conditions, estimated traffic numbers, aesthetics, and financial constraints must all be considered by the designer.

Furthermore, the bridge must be constructed in a structurally sound manner. This entails determining the forces that will be exerted on each component of the finished bridge. These forces are influenced by three different types of loads. The weight of the bridge itself is referred to as the dead load. The weight of the traffic that the bridge will bear is referred to as the "live load." Other external factors such as wind, probable seismic activity, and potential traffic collisions with bridge supports are referred to as environmental load. The analysis is carried out for the dead load's static (stationary) forces as well as the live and environmental loads' dynamic (moving) forces.

The usefulness of redundancy in design has been generally recognised since the late 1960s. This indicates that a bridge is built in such a way that the failure of a single element does not result in the entire structure collapsing. This is achieved by ensuring that other members are capable of compensating for a weaker member.

IV. DESIGN AND REINFORCEMENT DETAILS

A. Design of Deck Slab

If the deck slab spans just one direction, the bending moment for dead load can be calculated as if it were a continuous slab that spans all longitudinal girders. For concentrated loads, the effective width formula given in clause 305.16.2 of I.R.C. Bridge code IRC 21-2000 can be used to calculate the bending moment per unit width of slab.

The deck slab can be configured as a two-way slab if it is supported on all four sides. The curves are designed for slabs that are only supported on four sides. The values of maximum positive moments are multiplied by a factor of 0.8 to allow for continuity. The clear span is used as the effective span in design calculations.

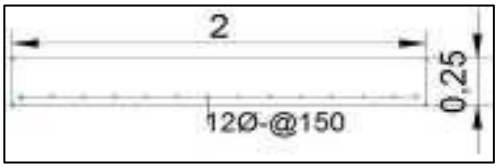

Figure 1: Reinforcement Details for One Panel Deck in Transverse Slab

B. Design of Cantilever Portion

The kerb, handrails, and, if present, a piece of the highway are normally carried by the cantilever component. The vertical section at the intersection of the cantilever part and the end longitudinal girder is the crucial section for bending moment. The effective width for cantilever is calculated using the formula specified in clause 305.16.2 of the Bridge Code IRC – 21: 2000 for bending moment owing to live load. The reinforcement should be detailed enough that the cranked bars from the deck slab might serve as half of the cantilever's main reinforcement. To offer the second half, the top bars of the deck slab can be extended to the cantilever. For the cantilever part, the distributors are calculated as 0.2 times the dead load moment + 0.3 times the live load moment.

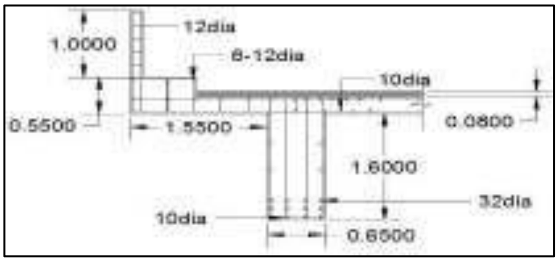

Figure 2: Reinforcement Details for Cantilever Slab

C. Design of Longitudinal Girders

Straight ribs are more practical for cranking main bars and would make formwork easier. As a result, for spans smaller than 18 metres, straight ribs are chosen.

The distribution of the live loads between longitudinal must be known before the bending moment owing to the live load can be computed. When there are just two longitudinal girders, the longitudinal responses may be calculated by assuming the deck slab supports are unyielding. The load distribution is calculated using any of the rational approaches when there are three or more longitudinal girders. Below are three of them:

- Courbon’s method
- Hendry-Jaegar method
- Morice and Little version of Guyon and Massonnet method.

The maximum response factor for intermediate and end longitudinal girders can be calculated using any of the preceding approaches. For these critical values of reaction factors, the bending moments and shears are computed.

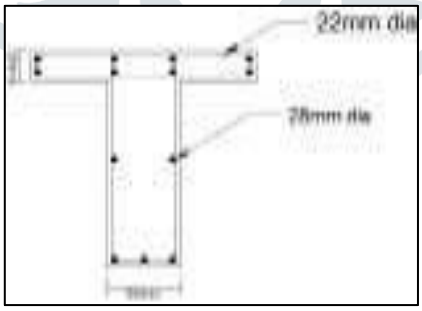

Figure 3: Reinforcement Details for Intermediate Longitudinal Grider

D. Design of Cross Beams

There is a dead load. B.M. is calculated using a trapezoidal distribution of deck slab and wearing course weights, as well as the self-weight. Over two spans, the cross beam is considered continuous. Different arrangements of the standard loads across the cross beams can be used to calculate appropriate weighted moment factors. Shears can also be calculated in the same way. The moment and shear levels can then be adjusted using reinforcements. To accommodate diagonal tension, additional cranked bars (typically two bars of 20ϕϕ or 22) may be added.

When a bulb is used, the depth of the intermediate cross beam can be adjusted using the approximation approach so that the bottom of the cross beam is at the top of the bottom flange of the longitudinal beam, or to a depth of at least 0.75 of overall depth when straight T-ribs are used. The cross beam width may be set to 250mm nominally. Reinforcements of 0.5 percent of gross area at the bottom and 0.25 percent of gross area at the top may be used. The end cross beam can also be reinforced with the same reinforcements. In most cases, nominal shear reinforcement of 12ϕ two-legged stirrups or 10ϕ four-legged stirrups at 150mm centres would suffice.

The end cross beam might be designed along the same lines as the intermediate cross beam. The depth of the end cross beam had previously been decreased to around 0.6 of that of the intermediate beam. When using elastomeric bearings, it is necessary to plan for the possibility of raising the deck to replace the bearings. As a result, the current practise is to maintain the end cross beam's depth the same as the intermediate cross beam's. The bottom reinforcement for the corresponding intermediate cross beam might be half of the bottom reinforcement. The top reinforcement remains unchanged. In addition, two broken bars of 20ϕ or 22ϕ are placed at the top to accommodate diagonal stress that occurs during the lifting process.

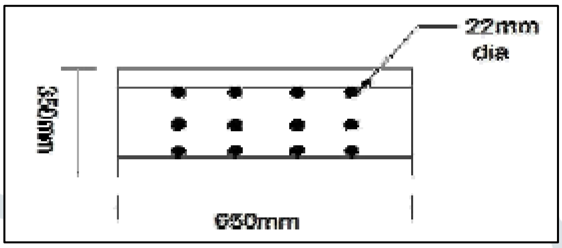

Figure 4: Reinforcement Details for Cross Beams

E. Design Of Abutment

In abutment design, the forces to be considered are:

- Dead load due to superstructure.
- Live load on the superstructure.
- Self-weight of the abutment.

Traction and braking forces, as well as temperature and concrete shrinkage, cause longitudinal forces.

The effect of live loads on the fill at the back of the abutment and the thrust on the abutment owing to retained earth. In design, the latter impact is treated as an analogous surcharge. All abutments must be constructed for a live load surcharge of 1.2m height of earth fill, according to the bridge code (article 714.4).

The ground pressure is the most challenging of the three factors to complete accurately.

The amount of earth pressure varies depending on the type of back fill material utilised and the moisture level. When building an abutment, it's critical to carefully put the fill material and ensure that it drains properly. An abutment is designed by assuming preliminary abutment section dimensions based on the kind of superstructure, substructure, and foundation, and then verifying for stability against overturning, base pressures, and sliding. The safety factor against overturning should be at least 2.0. Furthermore, so that there is no strain at the base, the eccentricity of the resultant of all pressures on the abutment should be within one sixth of the base width. The highest stress should not exceed the soil's safe carrying capability. The safety factor against slipping should be more than 1.5.

The front face of the breast wall should have a batter of about 1 in 25 to 1 in 12 for masonry abutments. The rear batter is adjusted to achieve the requisite breadth in order to keep the net pressure within the specified limits. It would be acceptable to have vertical faces on both the front and back sides of the breast wall if reinforced concrete abutments were used. The eccentricity of the resultant is restricted to one sixth of the base width due to the proportions of the toe and heel parts of the foundation slab.

F. Design Of Pier Cap

The minimum cap dimension to be used is 3’ deep by 2’-6” wide, with the exception that a 2’-6” deep section may be used for caps under slab structures. If a larger cap is needed, use 6” increments to increase the size. The multi-column cap width shall be a minimum of 1 1/2"wider than the column on each side to facilitate construction forming. The pier cap length shall extend a minimum of 2’ transversely beyond the centreline of bearing and centreline of girder intersection.

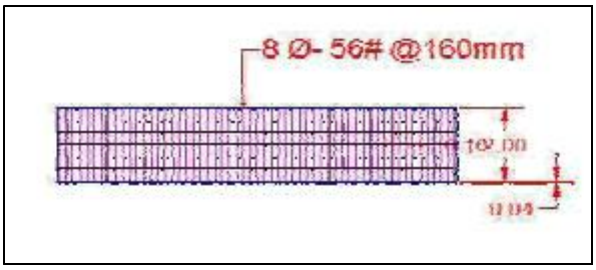

Figure 5: Reinforcement Details for Pier Cap

G. Design Of Pier

Reinforced concrete is used in the construction of cellular, trestle, hammerhead, and single column structures, which may reach heights of more than 6 metres and spans of more than 20 metres. The cellular type allows for a reduction in concrete volume, but it generally necessitates complicated shuttering and greater labour in the placement of reinforcements. The wall thickness should not be less than 300mm. The lateral reinforcement of the wall should account for more than 0.3 percent of the pier's sectional area, with 60 percent applied to the outer face and 40 percent applied to the inner face. It is normally kept at least 600mm larger than the bearing plates' out-to-out dimension, measured along the superstructure's longitudinal axis.

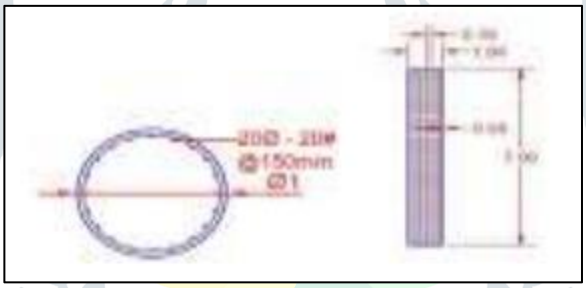

Figure 6: Reinforcement Details for Pier

The top pier's length must be at least 1.2m longer than the bearing plates' out-to-out dimension measured perpendicular to the superstructure's axis. The bearing plates are dimensioned so that the bearing stress due to dead and live loads is less than 4.2MPa.

H. Pile Patterns

The resistance created by bearing at the toe or skin friction along the surface, or both, transmits the load of a structure to competent sub-surface strata in piles. Pile foundation construction necessitates a thorough selection of piling system based on subsurface conditions and structural load parameters.

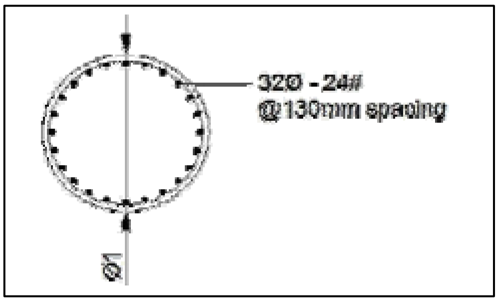

Figure 7: Reinforcement Details for Pile

V. CONCLUSION

IRC loading was used to finish the structural design of the bridge, which included deck slab, longitudinal girder, cross girder, bearing, pier cap, pier, pile cap, pile, and abutment. The proposed bridge is contrasted to the existing overloading on the bridge owing to traffic congestion. When 15 percent overloading occurs, the bridge is not safe when compared to the real loads from the IRC. Flexural failure has been recognised as the cause of the failure owing to overloading. As a result, several solutions such as everlasting bond reinforcement, carbon fibre wrap, CFRP sheet, CFRP laminates, beam jacketing, and pre-stressing the tendons can be used to prevent this failure.

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