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Analysis and Design of Prestressed I-Girder

Varun Kumar Sikka[1], Rohit Kumar[2]

[1]Assistant Professor, Department of Civil Engineering, Rattan Institute of Technology and Management, Haryana, India
[2]Research Scholar, Department of Civil Engineering, Rattan Institute of Technology and Management, Haryana, India

ABSTRACT

The industry of construction tops in the EU's GDP. The industry directly employs 10 million people (about half the population of New York). Additionally, it causes the development of new employment, quickens economic development, and presents environmental solutions to social, social and energy issues. The authorities aim to fostera more competitive environment within the sector and optimize resource utilization, ultimately promoting sustainability. The construction sector has been the worst fall that has been hit by the crisis financially. This report is going to be finished by diving into the core of the problem providing a vivid understanding of construction management. The academic prerequisites for the profession of construction manager and many plethora of responsibilities that they have will be examined .We will also, as a whole, go through the different management duties of a construction manager. This part will go into the detail of a construction manager's operation starting from the planning right through to the excavation .An example of this is a team taking care of all technical aspects of a project such as design, estimations, calculations and supervision. We will also mention that construction management as a discipline is basically connected to project management, safety protocols, technological advancements and legal regulations. Using qualitative methods, the research receives the receiver's questions to construction managers to examine the main issues construction sector is dealing with. Sentences, according to the author, related to knowledge's actual meaning, are what we get to understand from the integration.

INTRODUCTION

General

For the building of medium- and long-span bridges, prestressed concrete is perfect. Prestressed concrete was developed by Freyssinet in the early 1930s, and since then, it has been widely used in the construction of long-span bridges ,gradually taking the place of steel, which is prone to corrosion and requires expensive maintenance in harsh environments. Precast girders with cast-in-situ slabs are one of the superstructure types most frequently utilized in concrete bridge construction .Typically ,spans between20and 40 metres are utilised for this kind of superstructure. The most typical example in this category is the T-orI –girder bridge, which is highly well-liked due to its straight forward geometry, inexpensive manufacturing costs, ease of casting or erection, and lower dead loads.

I-Girder

In general, a bridge that uses girders to support the deck is known as a girder bridge .The superstructure (girder, truss, or arch),the deck, and the foundation (abutments and piers) make up a bridge. When discussing bridge design, the terms "girder" and "beam" are frequently used interchangeably. Nonetheless, some authors distinguish beam bridges from girder bridges in a somewhat different way. A beam experiences tension at the bottom and compression at the top when it bends .

Advantages of Prestressed Concrete

In terms of technology, prestressed concrete is far superior to the r building materials like steel and reinforced concrete. Because compressive prestress lowers the primary tensile stress ,prestressed concrete components have better resistance to shearing forces .Curved cables are a useful tool for reducing shear stresses created at the support sections, especially in long-span components. Prestressed members can be lighter and more slender than reinforced concrete because they combine high-strength steel and concrete.
Concrete that has been pre stressed has better energy absorption capacity under impact loads .It has been demonstrated that prestressed concrete may withstand repeated working loads just as well as reinforced concrete.

Materials for Prestressed Concrete

High-Pressure Concrete Blends Prestressed concrete necessitates concrete that is somewhat stronger in terms of tensile strength than regular concrete and has a high compressive strength at a reasonable age .For concrete used for prestressed members ,low shrinkage, lowest creep characteristic, and a high Young's modulus value are often considered essential. Concrete strength has a major impact on several desir able attributes, including durability, impermeability, and abrasion resistance. The advent of vibration technology around 1930 made it feasible to easily make high-strength concrete with a 28- day cube compressive strength ranging from 30 to 70 N/mm2.

Methods of Prestressing

Tendons in pretensioned members are taut even prior to concrete casting .While the other end of the reinforcement is pulled with a jack and fastened to a different abutment, the first end of there in for cement is fastened to an abutment .Next, the concrete is poured .

The ends of the reinforcement are freed from the abutment once the concrete has dried and solidified. Through bond action, the reinforcement that is inclined to revert to its initial length will compress the surrounding concrete.

Losses of Prestress

For a variety of reasons, the initial prestress in concrete gradually decreases over time from the stage of transfer .This is commonly known as prestress loss .The many kinds of losses that are experienced are listed below.

Losses in Pretensioning

1. Elastic deformation of the concrete;
2. Steel stress relaxation;
3. Concrete shrinkage
4. Concrete creep

Losses in Post tensioning

1. If every wire is tensioned at the same time, there is no loss because to elastic deformation .The concrete's elastic deformation will cause prestress to be lost if the wires are sequentially tensioned.
2. Steel's stress relaxation
3. Concrete shrinkage
4. Concrete creep
5. Displacement
6. Slip anchorage

Types of loads and stresses

The loads and stresses listed below must be taken into account while designing the prestressed I Girder.

1. The dead load
2. Live load

Dead load

The fraction of the superstructure's weight (as well as any fixed loads placed thereon) that is sustained entirely or partially by the girder or member, including the member's own weight, is known as the dead load carried by the structure.

Live load

Class AA Loading: This loading is to be implemented along specific roads, in specific current or planned industrial districts, in specific other regions, and inside specific municipal borders. Bridges intended for Class AA loading should also be inspected for Class A loading since, in some cases, Class A loading may result in higher strains.

Magnel Blaton system

In Freyssinet system several wires are stretched at a time. In Magnel Blaton system ,two wires are stretched at a time. This method was introduced by a famous engineer, Prof. Magnel of Belgium. In this system, the anchorage device consists of sandwich plate having grooves to hold the wires and wedges which are also grooved .Each plate carries eight wires.

Between the two ends the spacing of the wires is maintained by spacer's .Wires of 5mm or 7mm are adopted. Cables consist of wires in multiples of 8 wires. Cables with as much as 64 wires are also used under special conditions. A specially devised jack pulls two wires at a time and anchors them.

Gifford Udall System

This system originated in Great Britain, is widely used in India. This is a single wire system. Each wire is stressed independently using a double acting jack. Any number of wires can be grouped together to form a cable in this system

There are two type so fanchorage device in this

a) Tube anchorages

b) Plate anchorages

Lee McCall System

This method is used to prestress steel bars. The diameter of the bar is between 12 and 28mm. bars provided with threads at the ends are inserted in the performed ducts. After stretching the bars to the required length, they are tightened using nuts against bearing plates provided at the end sections of the member.

OTHER METHODS OF PRESTRESSING

Electrical Prestressing:

In this method, reinforcing bars is coated with thermoplastic material such as sulphur or low melting alloy and buried in the concrete .After the concrete is set ,electric current of low voltage but high amperage is passed through the bar .Electric current heats the bar and the bar elongates. Bars provided with threads at the other end are tightened against heavy washers ,after required elongation is obtained. When the bar cools, prestress develops and the bond is restored by re- solidification of the coating.

LITERATURE REVIEW

Loss due to elastic deformation of concrete

There is contraction as a result of prestress when it transfers to the concrete part. The wire loses some of its stretch as a result of this contraction .Prestress decreases when part of the strain is eliminated. This falls under the category of sudden loss. When the prestress in pretensioned concrete is Prestressing steel shortens in the concrete as well as the member when it is transmitted to it. Therefore, prestress is lost .Since the applied stress is recorded after the elastic shortening has fully occurred, there is no loss in post- tensioning if all of the cables are tensioned simultaneously. There will be tendon loss during the following stretching of additional tendons if the cables are tensioned in a sequential manner. The prestress loss resulting from concrete deformation is dependent upon the modular ratio & the average stress in concrete..

Long-Term Functionality And Durability

Keeping in mind the calamitous dangers of global warming, sustainable buildings must be built in such away that they may continue to resist bad weather conditionse. g. floods, storms and earthquakes. An individual who does not have adequate drains, pipes, and ventilation .Another important point is the use of durable materials, which may include wood, iron, or bricks.

Sustainable building is likely to be affected Prospect of future changes. This is where a clever lay-out which could be altered when necessitated changes be made, or even modular components that could be added with ease, would be useful.

Economicvi Ability

Lifecycleanalysisisirreplaceablewhenitcomestoproject’ssustainability, while taking on the same .Like the up-front cost for sustainable elements greater designers consider the lifelong financial benefits.

More so, sustainable buildings tend to be with an improved value of properties that can be easily transacted in the real estate market as the icing of the cake. Human population, through its awareness of environmental distress and quest for solutions to climate change, has made

Loss due to shrinkage of concrete

Concrete shrinkage is the contraction brought on by moisture loss .Because of the shrinking of concrete; the tendon's prestress gradually decreases. Long-term benefits in terms of durability and strength can be obtained by properly curing the concrete and postponing the application of load. reduction of prestress . In certain cases, precise calculations could be required to track shrinking strain over time.

Loss due to creep

Concrete creep is the gradual rise in distortion under continuous stress .Creep depends on time. Over time, the prestress in the tendon decreases as a result of concrete creep.

The ultimate strain in concrete is determined to be proportional to elastic strain for stresses in concrete that are less than one-third of the characteristic strength. The ultimate creep coefficient, also known as the creep coefficient, is defined as the ratio of the ultimate creep strain to the elastic strain.

METHODOLOGY

Process to making the prestressed concrete

First, we build there in for cement frame. Next, we apply the shutter and oil to ensure that it closes correctly. Finally, we add pipe in the shape of an u where the cable will travel through from one end to the other, carrying two loads: alive load and a dead load.

Using a power pack and hydraulic jack, we start the cable from the dead end and move it from the cable roll to the live end, where we stress the cable.

We tested the cable in the division to see how much strain it has to watch out for the ram and how far it is out of the jack.

This is done after the girder is cast .Next, we place the jack in ad I stressed position while holding the cable using a hydraulic power pack, wedges, and barrel.

ANALYSIS AND DESIGN OF PRESTRESSED I-GIRDER

Brief description of the proposal

Concrete

Controlled concrete of grade M45 giving cube strength of $45N/mm^2$ on 150mm cubes tested at 28 days is proposed for PSC girders, diaphragms and RCC deck slab.

High Tensile Steel

High tensile steel shall be the standard coated, stress relived confirming to IS: 6006-class II having a minimum ultimate tensile strength of 18.74t per strand. The wires shall be stress relived plain, cold drawn wires confirming to IS: 1785.

Design Aspect

In accordance with the sequence of construction and depending on the imposition of loads, forces and moments are encountered. Beams sections are checked for bending moment and shear force effects at various sections.

Design of PSC girder is in conformity with the IRC code of practice for plain reinforced and prestressed concrete. The end block design is in conform it with IS: 1343 code of practice for design of prestressed concrete structures and IRC:18.Deflection of the PSC girder is checked accounting for all long term and short term losses in prestress.

Design Data

For the design purpose following preliminary data was selected based on IRC recommendations.

The length of the girder is 21.1m and the centre to centre distance between the bearings is 20.3m. The deck slab width is 10.5m. It is simply supported by four numbers of prestressed post tensioned concrete girders spaced at 2.5m.

After considering the dimensions of the anti-crash barriers and the footpath the carriage way width was determined as 7.5m.

Depending on the size of the carriageway the type of the loading combination was determined from the Table No: 3.2. The load combination was found out to be as Two lane of Class A or One lane of Class 70R. Referring the IRC 18:2000 the minimum dimensions for the girders where fixed as:

Web Thickness: 300mm Top flange width:900mm

Bottom flange width: 800mm Overall Depth of Girder:1900mm

Minimum thickness of deck slab:250mm Minimum cover to steel: 40mm Minimum cover to duct: 75mm

Depending upon the bending moment diagram obtained from STAAD PRO the cable profile was decided to be as parabolic in nature. The various losses of prestress were determined in accordance with IS 1343:2000. The section was checked for ultimate shear and similarly the shear reinforcement was designed. The longitudinal reinforcements were designed in accordance with IRC18:2000 and them in immure in forcement was provided to be as 0.18%of the cross sectional area of concrete. Referring IRC 18:2000 clause 7.3 and clause 17 the end block and the bursting reinforcement was designed. The calculations of all the above stated particulars are shown in the following excel sheets.

CONCLUSION

Some of the conclusions that can be theorized are as follows:

1. Depending upon the bending moment diagram obtained from Staad Pro software a parabolic cable profile is provided
2. The values obtained by manual computation and that of Staad Pro software are found to be in good agreement.
3. The girder designed of dimensions

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