Study of Pre Stressed Concrete Used To Increase Tensile Strength

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Abstract- *Our project is dealing with Pre-stressed concrete which is used as flooring units in reinforced concrete moment-resisting frame buildings yet their behavior under fire has not received much attention. This is because large scale fire tests are difficult and expensive, leaving computer analysis as the only alternative. However, the currently available computer analysis methods are neither accurate nor easy to use. It describes a simple reliable computational method to be used in design for modeling the structural behavior of hollow-core pre-stressed concrete slabs exposed to fires. The model has a major limitation of not being able to model shear or tensile failure in the webs of the hollow-core units, but the simulation outcomes show reasonably good agreement with experimental fire tests of hollow-core slab units, thereby verifying the reliability of the model. In post-tensioned concrete, the tendons are tensioned after the concrete is placed and cured, and has achieved a predetermined required strength. After the tendons are stressed, they are anchored through the use of mechanical anchorages at each end of the member. There are two categories of post-tensioning tendons: bonded and unbounded .*

I. INTRODUCTION

In pre-stressed concrete structures, high-strength prestressing steel is used to increase load capacity, improve crack control, and allow the construction of more slender components. There are two main types of prestressed concrete: pretensioned and post-tensioned. In pretensioned concrete, the tendons (wires or strands) are tensioned before the concrete is placed and cured. After a predetermined required strength is achieved, the tendons are released. Prestressed concrete members are normally produced in a controlled environment. As a result, a higher quality concrete can be achieved. Standardized sections have been developed: I-beams, box beams, bulb-T, and modified bulb-T. Prestressed concrete deck panels are also produced.

In post-tensioned concrete, the tendons are tensioned after the concrete is placed and cured, and has achieved a predetermined required strength. After the tendons are stressed, they are anchored through the use of mechanical anchorages at each end of the member. There are two categories of post-tensioning tendons: bonded and unbonded. Bonded tendons are placed within ducts that were previously cast into the concrete. After the tendons are stressed and anchored, the ducts are filled with grout. Unbonded tendons are greased and then sheathed in plastic. Unbonded tendons are not used very much since it is difficult to ensure adequate corrosion protection. However, they have been used as external tendons to increase structural strength and integrity. In general, external tendons can be more easily inspected than internal tendons. Segmental bridges are a type of post-tensioned concrete structure where precast segments are joined together by post-tensioning tendons or bars.

II. LITERATURE REVIEW

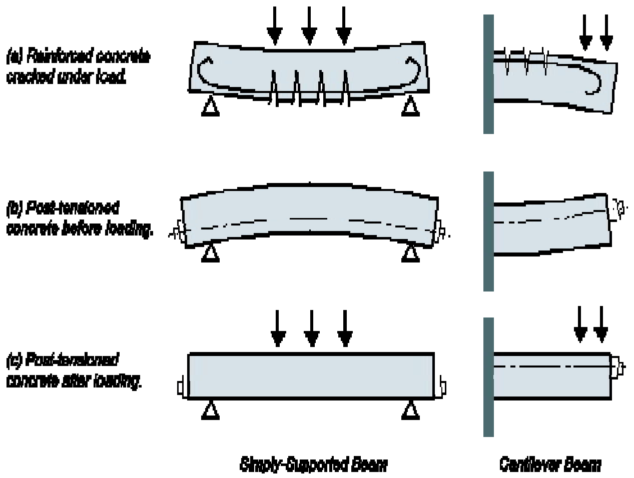
Although pre stressed concrete was patented by a San Francisco engineer in 1886, it did not emerge as an accepted building material until a half-century later. The shortage of steel in Europe after World War II coupled with technological advancements in high-strength concrete and steel made pre stressed concrete the building material of choice during European post-war reconstruction. North America's first pre stressed concrete structure, the Walnut Lane Memorial Bridge in Philadelphia, Pennsylvania, however, was not completed until 1951.

In conventional reinforced concrete, the high tensile strength of steel is combined with concrete's great compressive strength to form a structural material that is strong in both compression and tension. The principle behind pre stressed concrete is that compressive stresses induced by high-strength steel tendons in a concrete member before loads are applied will balance the tensile stresses imposed in the member during service.

Pre stressing removes a number of design limitations conventional concrete places on span and load and permits the building of roofs, floors, bridges, and walls with longer unsupported spans. This allows architects and engineers to design and build lighter and shallower concrete structures without sacrificing strength.

Damage to existing girder bridges that have undergone many years of service poses serious problems. Miyamoto proposed in 1997 to study the effect of prestressing using external tendons to strengthen the Misaka Bridge in Hyogo Prefecture, Japan. He carried out performance evaluations based on load test results and confirmed the effectiveness of using prestressed tendons to strengthen the bridge.

Dezi et al. (2002) proposed a model for analyzing the non-linear behaviour of steel-concrete composite beams prestressed by external slipping cables, taking into account the deformability of the interface shear connection.



Coff was granted a U.S. patent In 1950 for a composite steel beam and concrete slab system prestressed by means of draped cables. Analysis of prestressed composite beams using both elastic assumptions and approximate ultimate strength methods was also discussed in papers by Szilard and Hoadley(1963).

Hoadley's method of ultimate strength analysis was approximate in that the statically indeterminate tendon force corresponding to the ultimate load of the composite section was not determined from consideration of equilibrium and compatibility of deformation, but was assumed to equal the tendon force at first yield of the steel beam. Comparisons were made by Hoadley between the moment capacities of conventional and prestressed composite beams.

Three composite bridges were tested by Tachibana et al. (1964) using the principles of prestressing. The first bridge was supported on two supports while the remaining two bridges were continuous on three supports. They were all prestressed along their full length with 24mm diameter high-strength steel bars along the bottom flange in the positive moment region. The only difference between them was the sequence of prestressing their tendons. For Bridge 1 and 3, concrete was cast after the tendons were prestressed whilst for Bridge 2, the high-strength tendons were stressed only after the concrete had cured. The tests showed that the post-tensioning of Bridge 2 resulted in higher load-carrying capacity than Bridge 3, although the deflections and change in prestressing force in the elastic range remained roughly the same. The earlier cracking of the concrete deck over the interior support of Bridge 2, as compared to Bridge 3 concluded that prestressing for a negative moment region should be done before the casting of the deck for better performance.

Hoadley (1963) derived an expression for the increase in tendon force with applied load and evaluated the stresses in the steel beam and concrete deck of a prestressed composite beam, using the strain energy method and by assuming elastic behaviour. Based on the tensile failure of the tendon and the first yield of the steel beam, he also proposed a lower and upper bounds for the ultimate strength.

Stras (1964) tested three simply-supported, prestressed composite beams, all of them prestressed along their full length with 10mm diameter high-strength tendons at an eccentricity of 22mm from the tension flange. They were then compositely connected to the cast-in-situ concrete decks. The strain values obtained in the concrete slabs, steel beams and cable during the experiment correlated well with the calculated values.

Ng Chee Khoon (1997) tested a series of 18 beams ranging from 1.5m to 9m using L/d_{pso} ratio between 15 and 30 for their second order effects. From the experiment, it was concluded that the bond reduction coefficient recommended by Naaman can be modified by eliminating the length parameter as it has been proven that this parameter does not play a significant role in the increase in prestressing force in the pres tressed tendon. Of the beams tested, part of them failed by flexure and some by shear. Basically, there are three equations being discussed in the thesis. The first equation is for simply supported beams under third-point loading:

III. METHODOLOGY

GENERAL:

There are generally two methods are adopted for design of the prestressed concrete slabs

1 post pensioning method
2 pre tensioning method:

POST-TENSIONING

Post tensioning is a technique for reinforcing concrete. Post-tensioning tendons, which are prestressing steel cables inside plastic ducts or sleeves, are positioned in the forms before the concrete is placed. Afterwards, once the concrete has gained strength but before the service loads are applied, the cables are pulled tight, or tensioned, and anchored against the outer edges of the concrete.

Objectives of post tensioning:

The objectives of this document are: - to assist engineers in producing better designs which are easier and more economical to build; - to provide previously unavailable back ground design information regarding the more important VSL anchorages; - to be frank and open about what is actually being done and to disseminate this knowlege; and - to present a balanced perspective on design and.correct the growing trend of over - analysis. The emphasis is on design rather than analysis. The deformations required to produce the changes in tendon geometry necessary to develop the realizable capacity of the tendon are enormous and usually can not be sustained by the concrete.

A satisfactory design is possible if one examines what can go wrong during the construction and use of a structure, along with the resulting consequences. By looking at such fundamentals, one can readily deal with unusual construction and loading histories. For anchorages with the typical construction and load histories, one can conclude that the anchorage typically receives its maximum force during stressing when the concrete strength is 80 % f'c. In service, the anchorage forces will be smaller and the concrete strengths will be larger. It is possible to exceed the usual temporary jacking force of 80 % GUTS during stressing but not by very much and certainly not by a factor of 1.3. First, the operator controls the stressing jack to prevent excessive overstressing. Unless an oversized jack is used to stress a tendon, the jack capacity of about 85 % GUTS will automatically govern the maximum jacking force. Finally, if an oversized jack is used and the operator blunders (or the pressure gage is defective), the anchorage efficiency at the wedges will limit the realizable tendon force to about 95 % GUTS. This is accompanied by tendon elongations of at least 2 % (about 3 times greater than normal) which cannot go unnoticed. For anchorages in service it is possible but not usually probable that the anchorage force increases as discussed in point 6 above. Prestressed concrete is the main material for floors in high-rise buildings and the entire containment vessels of nuclear reactors.

Unbounded post-tensioning tendons are commonly used in parking garages as barrier cable Also, due to its ability to be stressed and then de-stressed, it can be used to temporarily repair a damaged building by holding up a damaged wall or floor until permanent repairs can be made.

The advantages of prestressed concrete include crack control and lower construction costs; thinner slabs—especially important in high rise buildings in which floor thickness savings can translate into additional floors for the same (or lower) cost and fewer joints, since the distance that can be spanned by post-tensioned slabs exceeds that of reinforced constructions with the same thickness. Increasing span lengths increases the usable unencumbered floorspace in buildings; diminishing the number of joints leads to lower maintenance costs over the design life of a building, since joints are the major focus of weakness in concrete buildings.

The prestressing of concrete has several advantages as compared to traditional reinforced concrete (RC) without prestressing. A fully prestressed concrete member is usually subjected to compression during service life. This rectifies several deficiencies of concrete. The following text broadly mentions the advantages of a pre-stressed concrete member with an equivalent RC member. For each effect, the benefits are listed.

A) Section remains un-cracked under service loads

1. Reduction of steel corrosion
   - Increase in durability.
2. Full section is utilized
   - Higher moment of inertia (higher stiffness)
3. Less deformations (improved serviceability).
4. Increase in shear capacity
5. Suitable for use in pressure vessels, liquid retaining structures.
   - Improved performance (resilience) under dynamic and fatigue loading.

B) High span-to-depth ratios

1. Larger spans possible with prestressing (bridges, buildings with large column-free spaces)
2. Typical values of span-to-depth ratios in slabs are given below.

For the same span, less depth compared to RC member.

- Reduction in self weight
- More esthetic appeal due to slender sections
- More economical sections.

C) Suitable for precast construction The advantages of precast construction are as follows.

- Rapid construction
- Better quality control
- Reduced maintenance
- Suitable for repetitive construction
- Multiple use of formwork
1. Reduction of formwork
- Availability of standard shapes.

Pre stressed composite beams have been studied by several authors. In 1949, Dischinger published a series of articles proposing the pre stressing of entire bridges by means of high-strength cables and also came up with the fundamental method of analysing pre stressed composite system for simple and continuous spans plate girder, highway bridges and railway bridge applications.In recent years, due to the ever-increasing traffic volumes and loads, the service conditions for bridges in Japan have become more and more severe.

The general objective is obviously to provide a safe and serviceable structure. The question is "What is reasonable ultimate and service design loads for strength and serviceability check Modern safety theory could be used to determine design loads by considering all of the relevant parameters as statistical variables and examining the combined effect of these variations. The net result would be load and resistance factors selected to provide some desired probability of failure. For example, if one took a load factor of 1.3 on the maximum jacking force, and a resistance factor of 0.75 for the anchorage zone, one would get a factored design load greater than realizable strength of the tendons - a physical impossibility! More significantly, the corresponding resistance factors result in unrealistically low predicted design strengths for the concrete. Using such proposed load and resistance factors would render most current anchorage designs unacceptable. Since the current designs have evolved from many years of satisfactory experience, one must conclude that it is the proposed load and resistance factors which are not satisfactory! Fortunately, by reviewing the construction and load history of a post-tensioning system, one can arrive at reasonable design values in a rational and practical manner.

THE FOLLOWING REMEDIAL MEASURES CAN BE APPLIED

If, after correction for the first two items, the variation is within allowable limits, the pre stressing can be accepted. If on the other hand the discrepancy is still out of specification and no evidence of faulty anchorages or fractured wires can be found, then a very low friction and a minus tolerance in wire diameter is likely. In this case the cable should be released and locked off at the specified force. If damage to anchorages or fracture of wires or strand has been established, the cable should be completely de-tensioned, the extent of damage investigated and remedial action proposed by the contractor. In the interim stressing of the remaining cables may proceed. If the actual cable extension is much less than the calculated one (say -8% and less), then check the following: (a) Actual and assumed E-modulus as above; and (b) Tolerance in cross-sectional area of the wire. The following remedial measures can be applied: If, after correction for the above two items, the discrepancy falls outside allowable tolerances, then excessive friction or blockage in the duct must be suspected. In this case it is prohibited to increase the cable force in order to obtain the calculated extension. Instead, the cable should be completely released and re-stressed (twice if necessary) and the extension measured again. If the extension now falls within tolerance, the cable can be accepted.

IV. CONCLUSION

Pre-stressing systems and the mechanisms utilized for providing corrosion protection of these systems are reviewed. A summary of experiences and problems during construction of PCCs is presented. Results obtained indicate that the few construction problems which occurred were identified and remedied prior to a structure being placed in service. A review of regulatory requirements relative to inservice inspections of prestressing tendons is presented. The few incidences of problems or abnormalities that were identified in these inspections were found to be minor in nature and did not threaten the structural integrity of the containments. In conclusion, the frequency of occurrence of incidences which could lead to a decrease in the functional capability of PCCs is small, especially considering the number of PCCs in service in the United States. Where problems did occur, they generally were the result of construction practices, and were identified and corrected during either the construction phase, the initial structural integrity test, or in subsequent inservice inspections. Thus it can b-i concluded that the inspections have been effective in achieving their desired objectives of uncovering and correcting potential problem areas

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