Laboratory Models for Assessing Pre-Compression Influence in Concrete

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Abstract

The project deals with the experimental study on the performance of high strength concrete by application of pre-tensioning to the concrete before concreting. In case of structural elements which are subjected to high stressing or loading can be made sustained by making the structural element able to with stand the imposed load. In this study, a high strength mix of M40 were casted where in other specimens were made with the help of applying the pre-stressing by stressing cables in single and double profile and casted after initial stressing in done. Because of applying pre-stressing, the element behaves in such a manner to develop its ability to withstand a higher load than the concrete specimen made out of control mix. The performance of this element casted will show a unique behavior than the control mix under flexural stress. The comparative study of the pre-stressed and plain concrete is studied experimental and their corresponding results were obtained.

This study will exhibit the ability of pre-stressed concrete over the plain concrete. It is expected to know the different types of construction procedures that are to be implementing, and different types of design mixes for designing of beams. It is also expected to know the procedures adopting for different techniques for casting of the pre-stressed beams. Thus it can be concluded that pre-stressing provides a means for the most efficient use of concrete.

Keywords: *Pre compression Influence, Concrete, High Strength Concrete, High Tensioned Steel*

INTRODUCTION

A pre-stressed concrete beam is a beam in which initial stresses are introduced in a planned manner so that when beam is subjected to external loading, the stresses across the section are practically compressive. High grade concrete and high tension steel wires are used. The steel wires are called tendons.Pre-stressing is a method in which compression force is applied to the reinforced concrete section. The effect of pre-stressing is to reduce the tensile stresses in the section to the point that the tensile stress is below the cracking stress. When any structural concrete element is subjected to flexure a portion of the element is in tension and another portion is in compression and in reinforced concrete elements, the entire tensile force is resisted by reinforcements and compression by concrete. But in the case of pre-stressed concrete element subjected to flexure, both compression and tension are resisted only by the concrete .The tension is resisted by initially applied compression in concrete, where as the compression is resisted by its own inherent quality of higher strength in compression, this behavior is valid up to the level of stage of decompression at the extreme tension fiber and tensile stress in the concrete going up to cracking stress. This concept is applied in the construction of segmental bridges, airport control towers, college dormitories, huge parking structures, for incomparable beauty and sustainability of office buildings

High strength concrete is necessary for the following reasons:

When the stress is transferred to concrete by bond action, the high strength concrete offers high bond stress. Shrinkage cracks will be very little. Due to the larger modulus of elasticity of high strength concrete, the elastic and creep strains are small resulting in smaller loss of pre-stress in steel reinforcement.

High tensioned steel is used for the following reasons:

Since mild steel has very low yield stress, if such steel is used, it has low tensile stress after tensioning. But due to creep and shrinkage of concrete the loss in stress takes place which is of the order of 200N/mm2 hence pre-stressed tension in steel reduces to very small or zero. But high tensioned steel is initially stressed to say 1000 N/mm2, hence a large stress will be still left after subtracting the losses.

STEEL STRENGTH REQUIREMENTS: High tensile strength is generally achieved by marginally increasing the carbon content in the steel in comparison to mild steel. The ultimate tensile strength is about 1500N/mm2, for wires of 5-7mm diameter. The tensile strength is somewhat less for wires of larger diameter than those of smaller diameter .Pre-stressing strand has greater tensile strength than pre-stressing wires .In high tension alloy and in pre-stressing steel no fixed peak is observed hence 0.2% proof stress should not be less than 80% of minimum ultimate tensile strength. Elongation of rupture (fracture strain) shall not be less than 2% over a gauge length of 200mm.

Permissible stresses in high tension steel

At the time of initial tensioning, the permissible tensile stress is 80% of ultimate tensile strength. Immediately after the transfer, the permissible tensile stress is 70% of the ultimate tensile strength. After allowing for all losses, tensile stress should not be less than 45% of ultimate tensile strength.

PRE-TENSIONING AND POST-TENSIONING:

In pre-tensioned members the tendons are tensioned even before casting the concrete. One end of the reinforcement is secured to an abutment while the other end of reinforcement is pulled by using a jack and this end is then fixed to another abutment. The concrete is now poured. After the concrete has cured and hardened, the ends of the reinforcement are released from the abutments. The reinforcement which tends to resume its original length will compress the concrete surround it by bond action. The pre-stressed is thus transmitted to concrete entirely by the action of bond between the reinforcement and surrounding concrete.

The post tensioned member is one in which the reinforcement is tensioned after the concrete has fully hardened. The beam is first cast, leaving ducts for placing the tendons. When the concrete has hardened and developed its strength, the tendon is passed through the duct. One end is provided with an anchor and is fixed to one end of the member. Now the other end of the tendon is pulled by a jack which is butting against the end of the member. The jack simultaneously pulls the tendon and compresses the concrete. After the tendon subjected to the desired stress, this end of the tendon is also properly anchored to the concrete. To avoid crushing of concrete due to excessive bearing stress, distribution plate is provided at each end.

OBJECTIVES:

The primary objective of the study was to provide a direct and quantitative comparison of the flexural behavior and strength of beams with four types of reinforcement proportionone tendon, two tendons, four tendons, eight tendons respectively of pre-stressed and unstressed beams. Particular emphasis was given to ultimate beam strength, mode of failure, deflection recovery at various percentages of ultimate load, and load deflection relationships from zero load to failure. Test results of 8 rectangular beams are given involving 4 unstressed and 4 pre-stressed. For 4 reinforcement percentages, the characteristics of these beam samples are compared in terms of deflection recovery, ultimate strength of beams failing in flexure.

Based on the experimental and analytical studies of flexural behavior and ultimate strength of beams, the relative performances of various types of pre-stressed and conventional reinforcement are compared.

Experimental work:

Fig: 1 Cable profile

The report is based on testing of 9 beams that are 4 fully Prestressed and 4 unstressed and one plain concrete beam and the principal results of which are tabulated below. All beams were of 100x100 mm .mm cross section and 500 mm length and were tested under three-point loading. The force of pre-stressing is 928 N. High strength concrete of grade M40 is used and the mix proportion of the ingredients is 1: 1.42: 2.38. The diameter of the tendon is 0.75mm

Fig 2: Compaction process

Fig:3 Concreted Prestressed beam

Wooden concrete mould is placed on the stressing frame with different cable profile. The Cables are tied on both the sides on the stressing frame. Application of load makes the cables stretched due to the load application. It is checked weather cables are firmly stretched. Desired concrete mix is adopted and super plasticizer is used to increase the workability due to the reduction in w/c ratio. Concrete is poured into the mould followed by the process of compaction. The concrete mould is left till the process of hardening takes place. After 24 hours samples are demoulded and placed in curing tank for 28 day curing process. The moulds are placed in flexural testing machine and ultimate load is determined.

The experiment is carried to determine the pre-compression effects in concrete by laboratory analysis. The samples with different number of tendons are casted, tested and compared by flexural test results. The graphs are plotted between load and deflection which is obtained from the flexural test conducted.

Fig4: Beam failure in flexure testing machine

RESULTS AND DISCUSSIONS:

All beams in the investigation failed in flexure. Differences in the overall comparative performance of the four types of reinforcement were observed in terms of ultimate load-carrying capacity, crack pattern, load- deflection characteristics, and deflection recovery properties. The variations in behavior may be traced by the difference in the stress-strain properties of pre-stressing and conventional reinforcement, the degree of bond between the steel and concrete, and the pre-stress which of course was absent in the conventionally reinforced beams.

Final failure in flexure of a reinforced concrete beam occurs when crushing of the concrete in the compression zone takes place. The stress-strain relationship of the reinforcement is a major factor governing the ultimate load-carrying capacity at which such crushing takes place.

Fig5: Cup- cone failure in tendons

Fig6:Specimens after testing

LOAD VS DEFLECTION GRAPHS

Table 1: Normal Pcc

DEFLECTION mm	LOAD kN
0	0
0	1
0	2
0	3
0.14	4
0.24	5
0.26	6
0.3	7
0.3	8
0.3	9
0.32	10
0.32	11
0.34	12
0.38	13
0.4	14
0.4	17

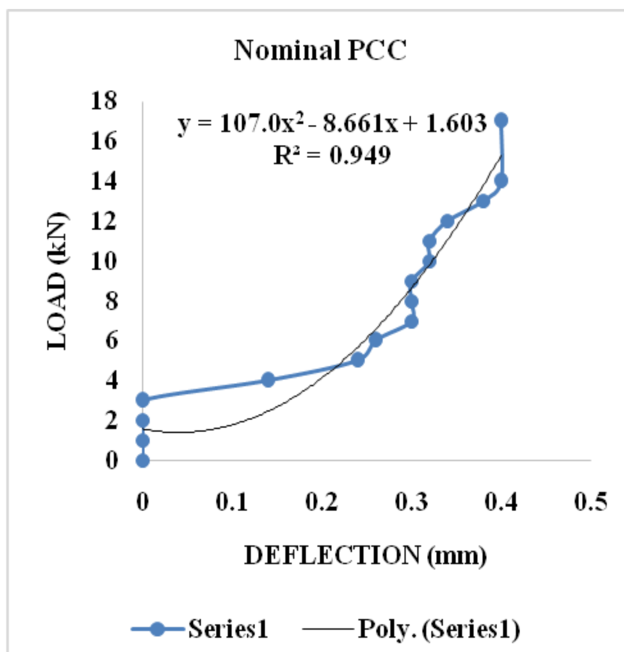

Figure7

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Table 2: Prestressed 1 Tendon

DEFLECTION mm	LOAD kN
0	0
0	1
0.024	2
0.028	3
0.036	4
0.044	5
0.044	6
0.048	7
0.048	8
0.052	9
0.264	10

Table 3: Prestressed 2 Tendons

DEFLECTION mm	LOAD kN
0	0
0	1
0.044	2
0.048	3
0.06	4
0.06	5
0.064	6
0.064	7
0.064	8
0.068	9
0.072	10
0.128	5

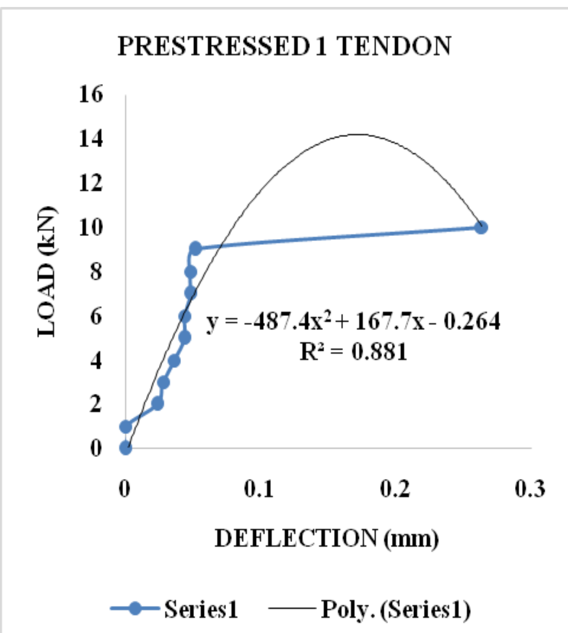

Figure 8

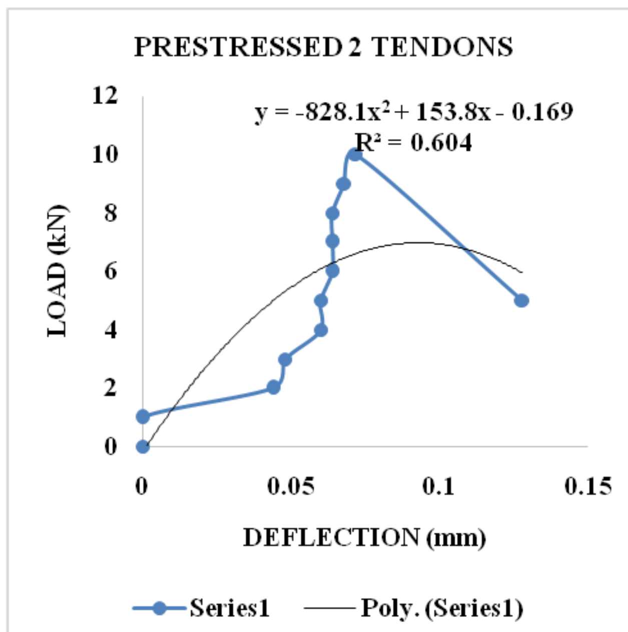

Figure 9

Table 4: Unstressed 1 Tendon

DEFLECTION mm	LOAD kN
0	0
0	1
0.008	2
0.012	3
0.02	4
0.024	5
0.028	6
0.032	7
0.032	8
0.036	9
0.044	10
0.048	11
0.048	12
0.052	13

Table 5: Unstressed 2 Tendons

DEFLECTION mm	LOAD kN
0	0
0	1
0.04	2
0.06	3
0.07	4
0.08	5
0.084	6
0.09	7
0.098	8
0.1	9

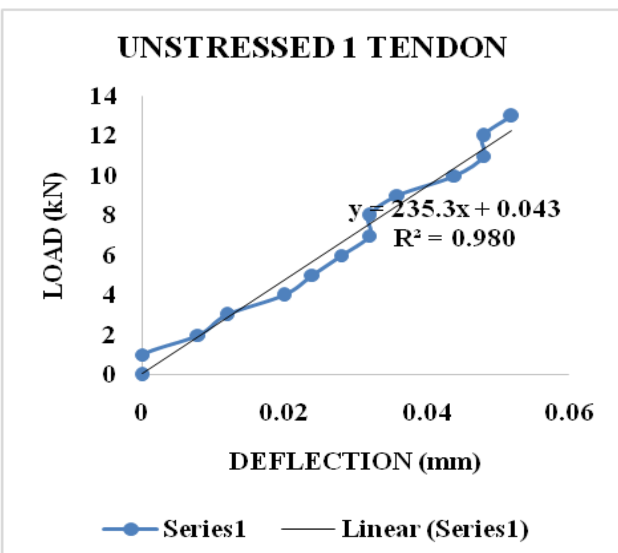

Figure 9

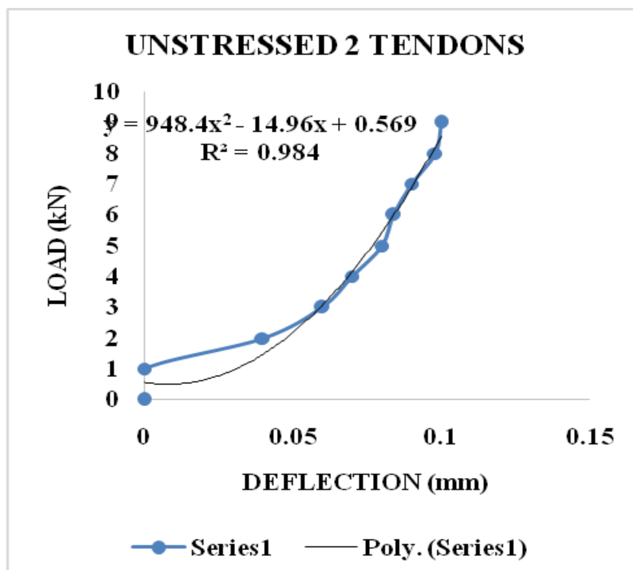

Figure 10

Table 6: Unstressed 4 Tendons

DEFLECTION mm	LOAD kN
0	0
0	1
0.28	2
1.96	3
2.6	4
2.9	3
2.92	3.5
2.96	4
3.54	3.5
3.58	3
3.66	2.5
3.74	2
5	2.5

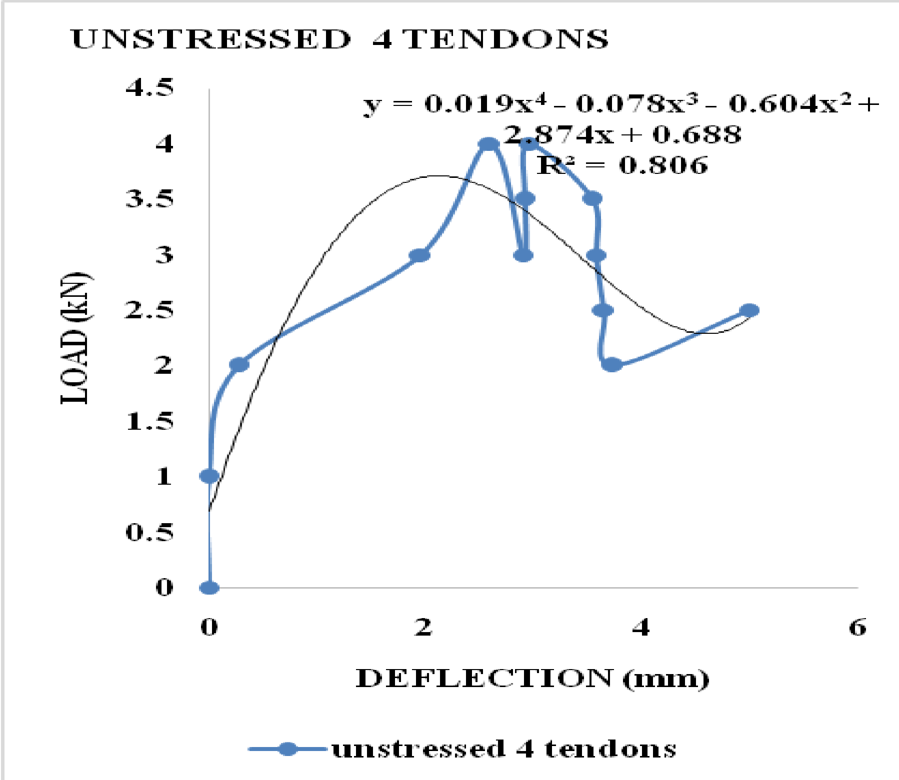

Figure 11

Table 7: Unstressed 8 Tendons

DEFLECTION mm	LOAD kN
0	0
0	1
0.08	2
0.084	3
0.084	4
0.086	5
0.12	6
0.16	7
0.2	8
0.24	9
0.26	10
0.38	11
0.42	12
0.446	13
0.632	14

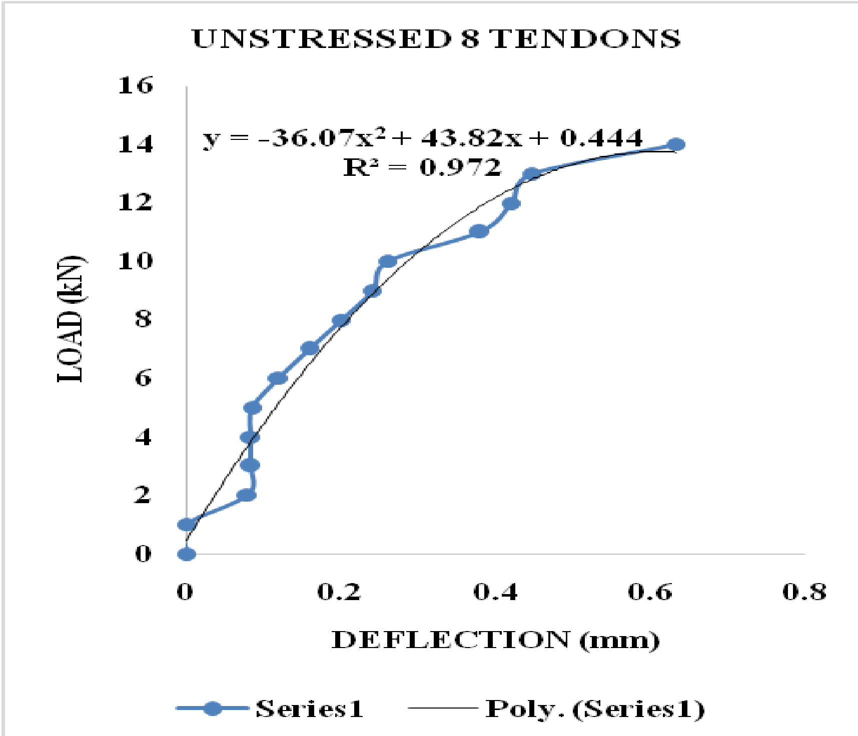

Figure 12

Table 8 : Prestressed 4 String

DEFLECTION mm	LOAD kN
0	0
0	1
0.082	2
0.092	3
0.096	4
0.11	5
0.124	6
0.146	7.5

0.294	4.5
0.704	4
0.754	4.5
0.804	5
1.184	5.5
1.624	3.5
1.744	1
2.134	0.5

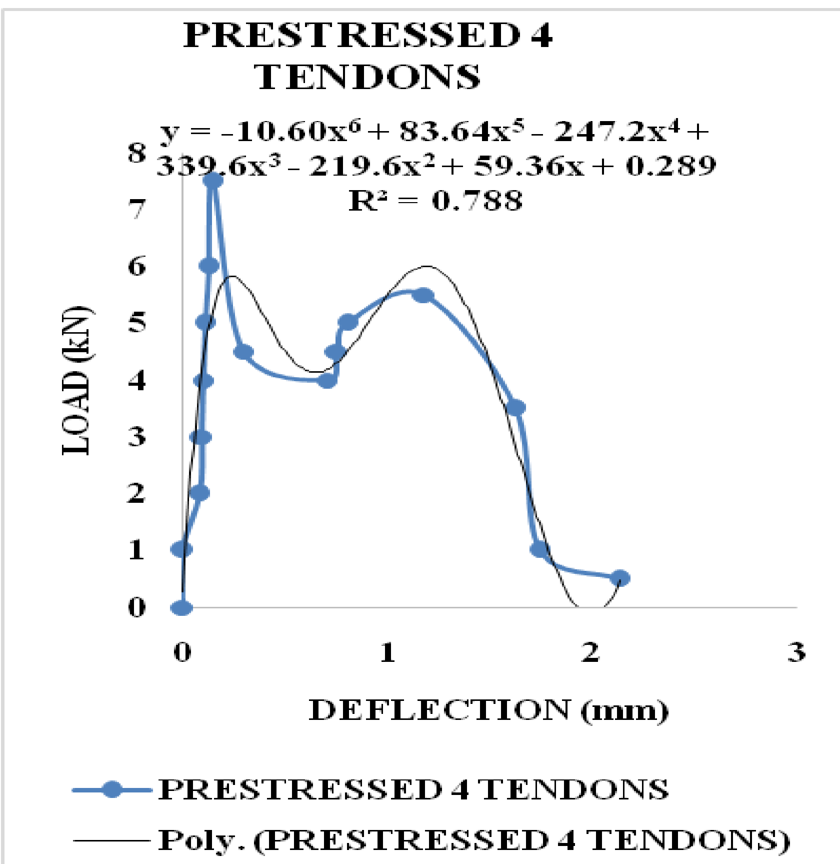

Figure 13

Table 9: Prestressed 8 Tendons

DEFLECTION mm	LOAD kN
0	0
0.22	1
0.24	2
0.24	3
0.3	4
0.32	5
0.34	6
0.36	7
0.42	8
0.45	9
0.468	10
0.488	11
0.534	11
0.56	11.5
0.6	12
0.92	12.5
1.08	12
1.2	12.5
1.42	12
1.46	12.5
1.54	12

1.68	10
1.8	7.5
1.96	7
2.12	7.5
2.14	7
2.34	6
3.24	5.5
4	5
4.4	2

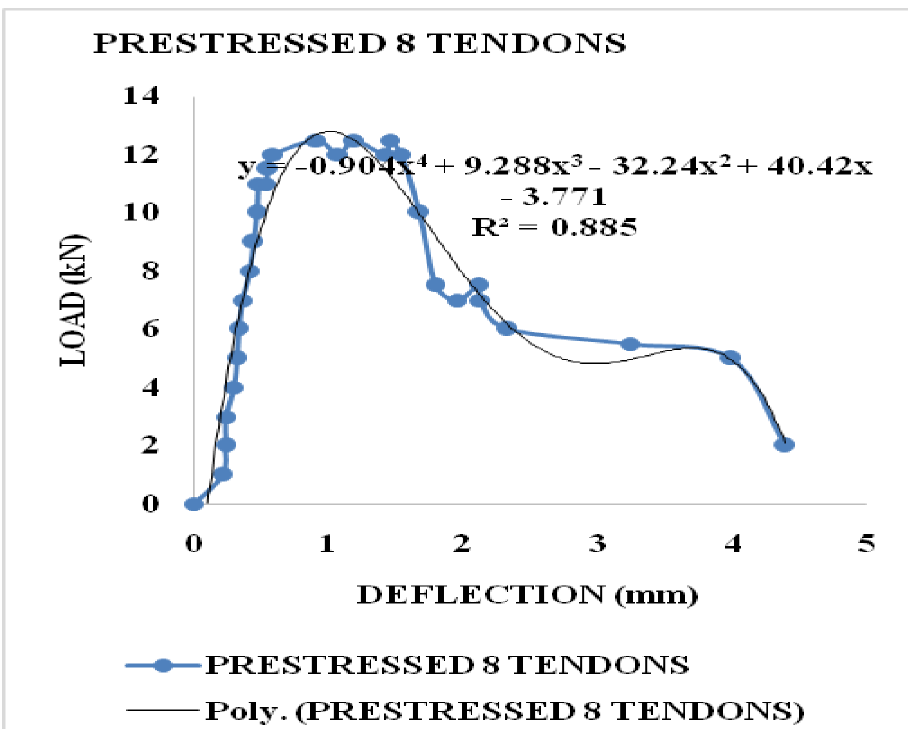

Figure 14

CONCLUSION

Pre-stressed concrete design and construction is an advanced process. The high stresses imposed by pre-stressing really do occur. The following points should be carefully considered to adequately protect against losses of pre-stress and to use the materials economically requires that the initial stresses at pre stressing be at the allowable upper limits of the material. This imposes high stresses, which the member is unlikely to experience again during its working life.

Thus this requires control and responsibility from everyone involved in pre-stressed concrete work - from the designer right through to the workmen on the site in bridge designs and commercial buildings.

As per the observed beam specimens it is found that the cracks vary in both stressed and unstressed sections. Prestressed concrete beams, of course, cracked at higher loads than conventionally reinforced beam on removal of load after cracking the prestressing force in the steel tends to pull tension cracks together and accordingly the deflection recovery of pre-stressed beams was superior to that of non prestressed beams. Midspan deflections were smaller for prestressed than for conventionally reinforced beams in the working load range. The deflection carrying capacity for the beams with more number of tendons is higher when compared to the less number of tendons.

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