

# International Journal of Innovative Research in Science, Engineering and Technology

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## Low Cost Housing Using Pre-Tensioned Precast Concrete Elements

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**ABSTRACT:** Low Cost Housing/ Building is a concept of innovative idea of budgeting techniques which help in reducing the cost of construction through the using locally available and or produced building materials along with the correct amount of workers without sacrificing the strength, performance and life of structure. There is immense misconception that Low cost housing is useful for only particular works and they are constructed by using cheap building materials of low quality. The fact is that Low Cost Housing technique is done by proper direction of resources. Economy is also achieved by postponing finishing works or implementing them in phases. This technique also helps in bringing down the cost of structure, promoting the use of locally available labourer to slowdown the movement of rural people towards metro city.

**KEYWORDS:** Low cost techniques , Housing, Structural component, Pre-tensioned precast concrete elements.

### I. INTRODUCTION

With ever increasing cost of building materials the construction moderate size and medium quality housing is becoming very difficult in rural India. To empower the economically backward rural semi urban masses of the country people the Government of India has implemented the scheme "Indira Awaas Yojana" since 2002 which helps in construction of houses. The dwelling proposed by this scheme is having sloping Galvanized Iron sheets supported by pipe purlin. The head room on one side is 2.7m (9') and 2.4m (8') on other side which is major cause for raised temperature inside the house. In the tropical belt of India the highest temperature start to cross 35<sup>o</sup> C from mid March which continues up to June end. These elevated temperatures make the house almost useless for said period of the year. Both purlin and sheets are of steel proves the roofing a costly item. There is every possibility that the sheets and purlins get corroded. Rural Appropriate Technology(RAT) can be broadly defined as technology relevant to real social needs that is accessible, affordable and empowering to the communities it serves and that use it. RAT has requirement as, only small amounts of capital, emphasizes the use of locally available materials, relatively less labour charges, and is affordable to individual families. Be understood, controlled and maintained without high levels of education and training, be able to be produced in small shops and villages, be adaptable and flexible, and include local communities in the innovation and implementation stages. Ultimately, RAT should not have any adverse environmental impact. The rationale of RAT resides in its empowerment of people at the grass roots level. Engineer's awareness of cultural diversity issues, social and ethical concerns, and the practice of proactive environmental stewardship are all important components of utmost importance in RAT. Developmental professionals agree that local needs can be met more effectively with the community working to address their own needs. Tools that are developed should extend, not replace, human labour. RAT also emphasizes controllable scales of activity.

### II. METHODOLOGY

Prestressing is the application of a predetermined force or moment to a structural member in such a manner that the combined internal stresses in the member, resulting from this force or moment and from any anticipated condition of

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external loading, will be confined within specific limits. Prestressing, in its simplest form, can be illustrated by considering a simple, prismatic flexural member of rectangular in cross section stressed by a concentric or eccentric

force. It is easily seen that if the flexural tensile stress in the bottom fiber, due to the live and dead loads, are eliminated by the compressive stress due to applied prestressing is equal in magnitude to the sum of this stress resulting in zero stress at working load. Pre-tensioning and post tensioning are the two types to achieve aforesaid effect. For the present study former type is adopted for pre-tensioning the slab panels in which time-dependent reduction of in the prestress, due to the elastic shortening, creep and shrinkage of the concrete and the relaxation of the prestressing steel. If no tensile stresses are to be permitted the concrete, it is necessary to provide an initial prestressing force that is larger than would be required to compensate for the flexural stresses resulting from the external loads alone. Generally result in a reduction of the initial prestressing force by 10 to 25 %. Therefore, if the stress distributions are desired after the loss of stress has taken place under the effects of the final prestressing force, the distribution of stresses under the initial increased prestressing force would have to be considered. Prestressing with the concentric force just illustrated has the disadvantage that, the top fiber is required to withstand the compressive stress due to prestressing in addition to the compressive stresses resulting from the design loads. It is evident that the average stress in the beam, prestressed with the eccentric force will be less than that required for the beam with concentric prestress. Therefore, the total prestressing force required to develop the desired prestressing of the second case will be less than that required in the concentric prestressing. The economy that results from applying the prestressing force eccentrically is obvious. Further economy can be achieved when small tensile stresses are permissible in the top fibers-these tensile stresses may be due to prestressing alone or to the combined effects of prestressing and any external loads that may be acting at the time of prestressing.

### III. TESTING OF GALVANIZED WIRE

This test was aimed to determine the tensile strength of given specimen of wire and to plot the stress strain curve to study the effect of tensile loading. To evaluate mechanical properties of material in an initial period, tensile test is most useful information about yield strength ultimate tensile strength for locally available wire. Stress-strain diagram shows the performance of tested material by graphically expressing the stress exerting in the specimen as a function of strain of pulling action of the Universal Testing Machine (UTM) from the start of pulling to the occurrence of failure. During the test force and the matching deformation were recorded. The extended length at any point of loading is original length plus the elongation. The typical results of the test for 4 mm diameter wire are presented in Table 1 and the stress strain curve is plotted as Figure 1.

Results	Description
4	Diameter (mm)
250	Length (mm)
12.56	C/S area (mm <sup>2</sup> )
9700	Max. Load (N)
330	Final Length (mm)
1.5	Diameter
32	%age elongation
772.29	Ultimate

Table:1 Tension test data for 4mm wire

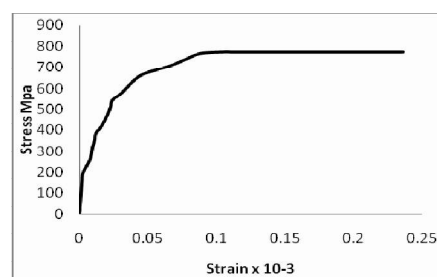


Figure 1: Stress strain curve for 4mm diameter

### IV. SYSTEM MODELING

For experimental setup the model of 3.05 x 3.05m roof is taken into consideration to study the position of pre-tensioned beam and slab panels as shown in figure 2. In the model the slab panels are placed with slope 1:10 is

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considered for proper drainage of rain water. Slab panel of size 1.05 x 0.6 x 0.025m can be placed on 6 beams of cross section 100 x 200mm. the grade of concrete grade used was M20. The detail calculation by considering live load and dead load were worked out and the pre-stressing was done accordingly. In this model the water proofing is also considered , the single coat of plaster of 6mm thick can be applied on the roofing system so that the leakage at joints can be prevented. Due to the sloping nature of roof the side gutters can be provided which can be adopted for rain water harvesting also. The model shows nearly 30% of saving if compared with conventional RCC slab and beam system. The other considerations in preparing the model were as making use of fly-ash, crushed sand and other eco-friendly material. The pre-stressed elements are light weight and can be erected easily. Due to pre-stressing to very little shrinkage cracks were recorded

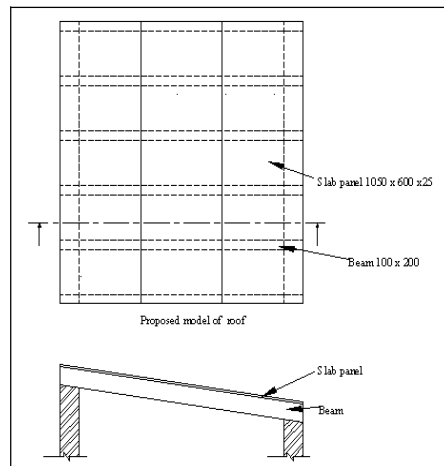


Figure 2 Proposed model of Roof System

## V. PERFORMANCE ANALYSIS

Following assumptions are made in connection with the moment curvature analysis wires are bonded to the concrete. Changes in strain in the steel and concrete after bonding are assumed to be the same. The initial strain from the effective pre-stress in the tendon, when no moment from applied loads acts on the section. At the level of steel, the concrete compressive strain exists while the tendon has a tensile strain which corresponds to the stress which is initially effective. Stress- strain properties for the material are known or assumed for use of analysis. Strains are assumed to be distributed linearly over the depth of the beam. Tension and compression forces acting on the cross section must be in equilibrium for the beam which has only flexure without any applied axial load. Ultimate moment corresponds to the occurrence of a strain in concrete which causes crushing or a steel strain which would fracture the tendon. The failure analyzed is in flexure, and it is assumed that the member will have adequate shear strength to prevent failure. Bond and anchorage of steel is assumed adequate to prevent failure prior to reaching flexure strength at the section being analyzed. The moment- curvature analysis allows the total range of performance to be examined up to the last point is the ultimate moment. We will find this total curve useful later in making estimates of ultimate deflection. It is generally true; however, that the load deflection curve for a beam will have the same form as the M- $\Phi$  curve (Figure 3 to Figure 6). Thus, the curve indicates ductile behavior which we want in structural design. The curvature at the ultimate moment is much larger than that at cracking, and most designs of pre-stress concrete beams limit stress at service load to keep the beam un-cracked. The versatility and reliability of moment curvature analysis are apparent in the observed test results shown compared to calculated response. Note that this curve is for a member with both pre-stressed strands and unstressed reinforcing bars. The procedure for finding moment and corresponding curvature for points defining the M- $\Phi$  curve for this beam would be done in step by step manner. In the Following Experimental work the testing of Pre-tensioned Slab and Beam is

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done the loading condition is two point (kN) and the deflection is also noted at the same time. Thus the bending moment is calculated and the angle  $\Phi$  is calculated from the deflection and Span. Moment is calculated considering the applied load and self weight of the member. Bending moment is calculated and the angle  $\Phi$  is calculated from the deflection and Span. Moment is calculated considering the applied load and self weight of the member.

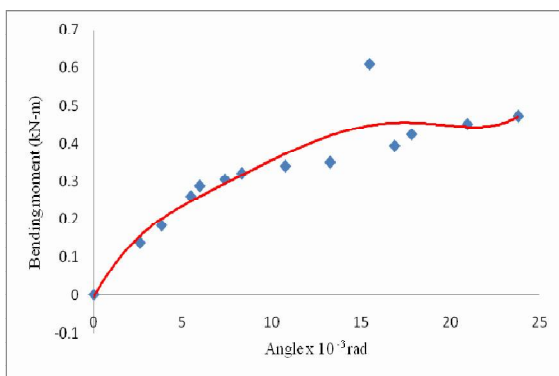


Figure 3: Bending test on untensioned slab

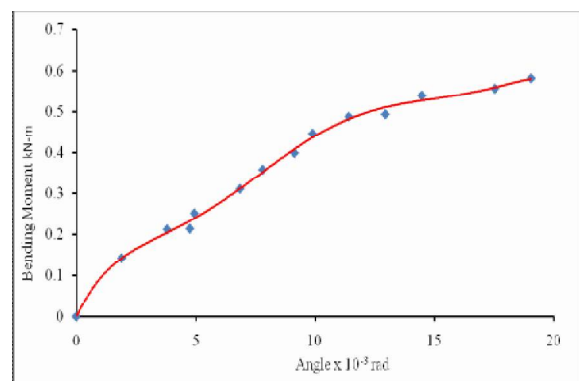


Figure 4: Bending test on Pretensioned slab

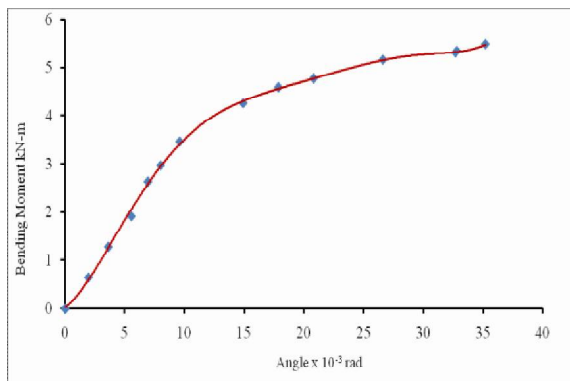


Figure 5: Bending test on untensioned beam

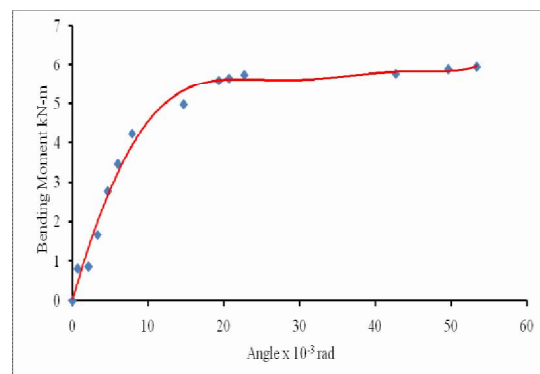


Figure 6: Bending test on pre-tensioned beam

## VI. RESULTS AND DISCUSSIONS

The Pre-tensioned slab panel was designed to carry accessible roof live load and self weight. The testing of this panel for two point load bending test shows that, the panel shows first crack on tension side at moment approximately 40% more than the anticipated at average deflection of 1.4 mm at mid-span of simply supported panel of 600 mm span. There after the load carrying capacity increase with slower rate compared to that of the deflection and crack width. Most of the slab panels failed by crushing of concrete at mid-span region on compression side. Few panels also failed due to crushing at supports. It was noted that, there was perfect bonding between concrete and the pre-stressing wires. Since the pre-stressing was concentric i.e. the wires were at mid depth of the section, fall at neutral axis due to bending and the force in the wires was less compared to their ultimate strength. None of the wires found broken at the time of failure. The moment curvature relations are shown in Graph. Beam 3m long was pre-stressed with 6 wires of 4mm diameter at an eccentricity of 43mm below neutral axis in total depth of 200mm. During testing the behavior was as anticipated. The simply supported span for flexural test was adopted 2.84m. The cracks propagation started at 50% more moment than anticipated design moment, exactly at mid-span on tension side when the deflection was approx 5.5mm. More crack started developing

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in the vicinity of the first one with increase in the loading with rapid increase in deflection. The failure was due to yielding of steel on tension side. In one specimen the crushing of concrete at support was also noted, this may be due poor concrete at end portion of the beam and absence of stirrups. No failure due to breaking of pre-tensioning wires is recorded. The moment curvature relations are shown in all the

## VI. CONCLUSIONS

As a result of this study, comparison between RC elements and Pre-tensioned elements done. The emphasis has been given to the pre-stress technology at the rural level in which structural aspects such as load, deflection, nature of bending moment along with the performance. The galvanized wire used as a pre-stressing material gives relatively higher tensile strength as compared to mild steel. Higher Moment of Resistance is recorded for pre-tensioned members as compared to RC members The extreme fiber stresses obtained from bending tests shows good resemblance with the calculated at first crack level. Deflection in pre-tensioned beam and panel is less for extreme load than that of non pre-stressed counter Part. So far as serviceability is concerned, the strength and manufacturing techniques is just well at lower cost. As safety is concerned, all precaution are taken in casting of panel, the results of testing of both steel and concrete has proved it can be achieved with local labors. From an economic point of view it is one evident that smaller quantities of material both steel and concrete are required to carry the high loads as such saving in stirrups diagonal tension is further minimized. Once the fabrication and lever arm technique is developed the labor cost can be minimized. Thus the method is simple rational and accurate with all design steps. Since the total quantity of aggregate and cement used in proposed model is less, results in less exploitation of natural resources. The proposed roofing system can be erected at approximately 70% cost of RC roofing. This cost can be further brought down if the members are manufactured on large scale.

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