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Original Article

Effect of Tendon Profile on Deflections in Prestressed Concrete Beams using C Programme

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Abstract *- Computer programming is to develop analytical skills and problem-solving abilities. C programming is a general-purpose powerful high-level language. Coding is applicable now in almost all industries. In most design offices today, the calculation is routinely performed on computers using software, thereby completing the work process easily before the scheduled period. In civil Engineering, the modules like Engineering Mechanics, Strength of Materials, Structural Analysis, Design of Reinforced cement concrete element and Steel structures involve complex Engineering problems. Various steps and empirical formulas were followed to perform the analysis and design problems by manual methods. Many times redesign of the section is necessary to satisfy the codal provisions, which again consumes more time and Energy. All this can be addressed easily in a programming language very simple and effective way. This paper involves the estimation of deflection of prestressed concrete beams with different cable profiles of straight tendons, parabolic tendons, parabolic tendons with eccentric anchors, trapezoidal tendons, sloping tendons, parabolic and straight tendons with the basic concept of C programming and condition of If statements. The output obtained by this method is compared with the suitable analytical method.*

Keywords — *Prestressed concrete beam, eccentricity, youngs modulus, the width of the beam, depth of the beam, moment of inertia, grade of concrete*

I. INTRODUCTION

The behavior of structural concrete members at the multiple limit states of which deflection forms an important criterion for the safety of the structures. It is the general practice, according to various national codes that, structural concrete members should be designed to have adequate stiffness to limit deflections, which may adversely affect the strength or serviceability of the structures at working loads. Excessive sagging of principal structural members is not only unsightly but, at times, also renders the floor unsuitable for the intended use. Large deflections under dynamic effects and under the influence of variable loads may cause discomfort to the users. Excessive deflections are likely to cause damage to finishes, partitions, and associated structures. The factors influencing deflections are Self-weight and superimposed load, Magnitude of prestressing force, Cable profile, Second moment of area of cross-section, Modulus of Elasticity of concrete, Shrinkage, creep and relaxation of steel stress, Span of the member, and Fixity conditions. The IS 1343–1980 code prescribes the limits for the prestressed concrete flexural member. The final deflection (including no effects of temperature, creep, and shrinkage) that occurs after construction of partitions and finishes should not exceed the least of span/350 (or) 20 mm. The loads applied after the construction of partitions and finishes will be, in general, the live load. This deflection limit is aimed to prevent damages to partitions and finishes. When finishes are applied, the total upward deflection should not exceed span/300. The final deflection due to all the loads (including the effects of temperature, creep, and shrinkage) should not exceed span/250. This limit is specified for the purposes of control of cracking and to prevent psychological discomfort to occupants.

II. SLOPE AND DEFLECTION OF BEAM

Short-term or instantaneous deflections of prestressed members are governed by the bending moment distribution along the span and the flexural rigidity of the members. Mohrs moment area theorems are readily applicable for the estimation of deflections due to the prestressing force, self-weight, and imposed loads. Consider Fig. 1, in which the beam AB is subjected to a bending moment distribution due to the prestressing force or self-weight or imposed loads. ACB is the centerline of the deformed structure under the systems of given loads.

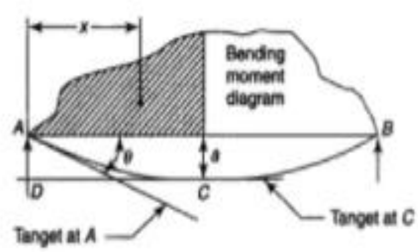


Fig 1: Slope and Deflection of Beam

If Θ = slope of the elastic curve at A
AD = intercept between the tangent at C and the vertical at A
a = deflection at the center for symmetrically loaded, simply supported beam (since the tangent is horizontal for such cases)
A = area of the BMD between A and C
X = distance of the centroid of the BMD between A and C from the left support.
EI = flexural rigidity of the beam
Then according to Mohrs first theorem
Slope = area of BMD / Flexural rigidity
$\Theta = A / EI$
Mohr's second theorem states that
Intercept, a = moment of the area of BMD/ flexural rigidity
$= Ax / EI$

III. EFFECT OF TENDON PROFILE ON DEFLECTION

In most of the cases of prestressed beams, tendons are located with eccentricities toward the soffit of the beam to counteract the sagging bending moment due to transverse loads. Consequently, the concrete beams deflect upwards (camber) on the application or transfer of prestress. Since the bending moment at every section is the product of the prestressing force and eccentricity, the tendon profile itself will represent the shape of the BMD. The method of computing deflections of beams with different cable profiles is outlined in table 1

IV. METHODOLOGY

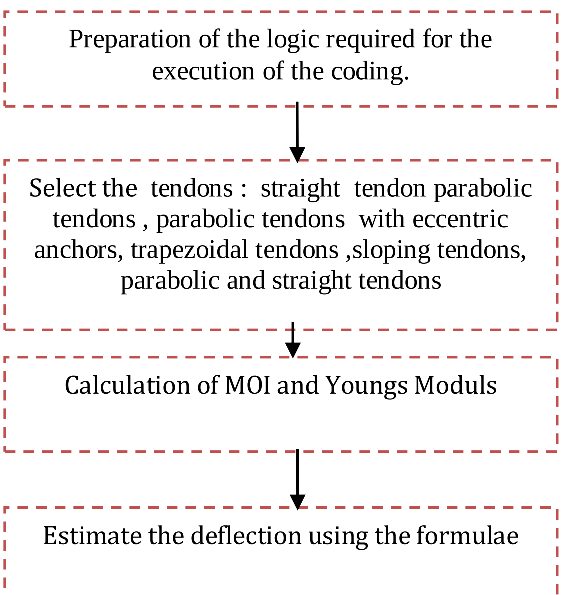
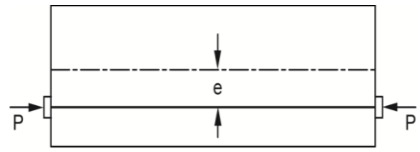
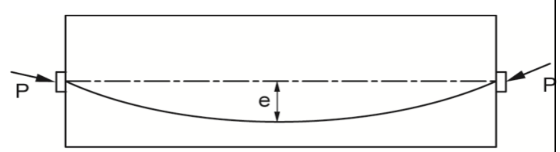
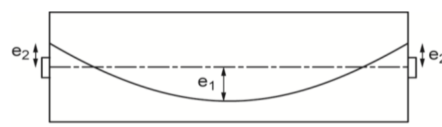
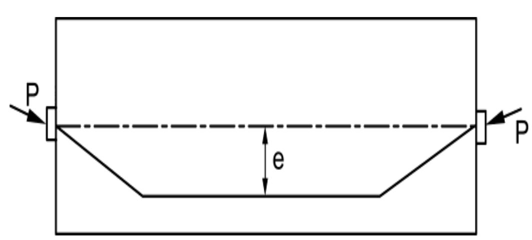
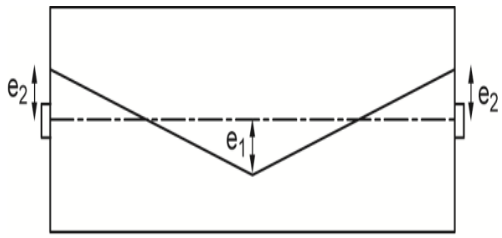
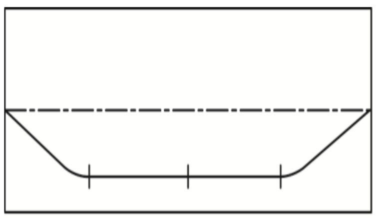


Table -1: Different Cable Profile

Sl.No	Tendon Profile
1	 *(a) Straight tendon* B - the breadth of the beam D - Depth of the Beam L - the span of the Beam P - Prestressing force e - Eccentricity of the tendon I - MOI of the Section E - Young's modulus of the Concrete $5700 \sqrt{c}$ C = Characteristic strength of concrete $\Delta STP = PeL^2 / 8EI$
2	 ***(b) Parabolic tendon with zero eccentricity at the supports*** $\Delta STP = 5PeL^2 / 48 EI$
3	 ***(c) Parabolic tendon with eccentricity at the supports above the centoridal axis*** $\Delta STP = PL2 / 48 E I \quad [-5e1 + e2]$ e1 = eccentricity of tendon at mid span e2 = eccentricity of tendon at support
4	 ***(e) Trapezoidal tendon with zero eccentricity at the supports*** $\Delta STP = (P e/6EI) (2L1^2 + 6L1L2+3L2^2)$

5	*(d) Linearly bent tendon with eccentricity at the supports above the centroidal axis* $\Delta_{STP} = (P\, e/6EI)\ (2L_1^2 + 6L_1L_2 + 3L_2^2)$
6	*(f) Straight and parabolic tendon with zero eccentricity at the supports* $\Delta_{STP} = -(P\, e/12EI)\ (5L1^2 + 12L1L2 + 6L2^2)$

V. ALGORITHM

A set of statements can be conditionally executed using an if statement. Here, the logical condition is tested which, may be either true or false. If the logical test is true (non zero value), the statement that immediately follows it is executed if the logical condition is false, then control transfers to the next executable statement.

```
E = (5700.0*(sqrt(c)));
I = w*(pow(d,3)) /(12);
 if (a==1)
 {
S = (P*1*(pow(10.0,3))*e*(pow(L,2)));
Def= (S)/((8.0)*(E*I));
  if (a==2)
 {
S = (P*1*(pow(10.0,3))*e*(pow(L,2)));

Def= 5.0*(S)/((48.0)*(E*I));
}
  if (a==3)
 {
S = (P*1*(pow(10.0,3))*(pow(L,2)));
R = (e2-(5.0*e1));
Def= (S)/((48.0)*(E*I))*R;
 }
   if (a==4)
 {
S = (P*1*(pow(10.0,3))*(pow(L,2)));
R1 = (e2-(2.0*e1));
Def= (S)/((24.0)*(E*I))*R1;
}
 if (a==5)
  {
S1 = (P*1*(pow(10.0,3))*e)/((6.0)*(E*I));
R2 = (2*pow (L1,2) + (6*(L1*L2))+(3*pow(L2,2)));
Def=(R2*S1);
 }
 if (a==6)
  {
S2 = (P*1*(pow(10.0,3))*e)/((12.0)*(E*I));
R3 = (5*pow(L1,2) + (12*(L1*L2))+(6*pow(L2,2)));
Def=(R3*S2)
```

Out put

1.st.tn , 2. pa.tn, 3. p&e, 3.bentn, 5tapetn, 6.pandst 2. enter the length in mm, 6000, enter the grade of concrete , 40, E:36049.964844, enter the width , 150, enter the depth ,300, enter P , 2000, enter e , 50, enter e1,0 ,enter e2 , 0,enter L1 , 0, enter L2 , 0, I:337500000.00, S:3599999980011520.0, Def=30.821419

VI. CONCLUSIONS

The output result of deflection of Prestressed concrete beam with different tendon profiles is presented here. It was observed that the output results are exactly the same as the manual calculation. Similarly, in a single program, the results of deflection of the prestressed concrete beam with straight tendons, parabolic tendons, parabolic tendons with eccentric anchors, trapezoidal tendons, sloping tendons, parabolic and straight tendons are estimated. The manual method is time-consuming and involves repetitive calculations. Hence it is better to use C programming code to easily get the result with minimum time.

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