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# Composite Delta Beam for Slim Floor Construction

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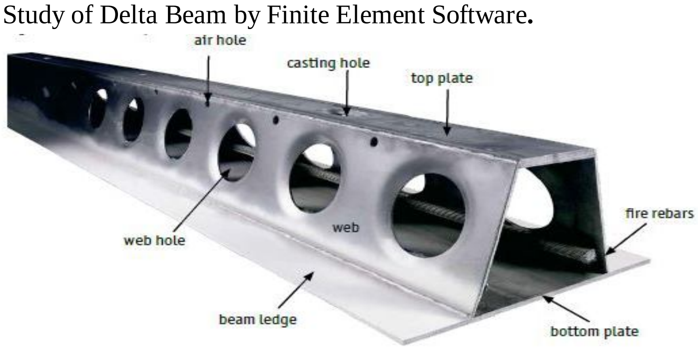
***Abstract: The structural behaviour of the composite Flush Beam for slim floor as a whole has been investigated. The deformation behaviour of the structural members Steel beams with trapezoidal cross-sections and specially punched webs were developed as composite beams in slim floors. The estimation of the flexural stiffness and bending capacity of composite slim beams is rather complicated, because the influence of many factors should be taken into account. These factors include variable section dimensions, Profile of the beam, stiffness of the beam and interaction between steel and concrete. In this paper, analytical investigations have been conducted to investigate the deflection behaviour of Flush beam specimens under monotonic loading. A design procedure is developed for composite slim floor Flush beams based on cross-sectional analysis and the flexural properties of the slim floor beams are evaluated. From the analytical investigation it was found that the deflection of delta beam is 48% less than the conventional I-beam More over the stiffness of the Delta beam is 49.8% higher than the I-beam.***
***Keywords: Study of Delta Beam by Finite Element Software.***

## I. INTRODUCTION

The goal of this report is to study the structural behaviour of the composite delta beam under loads is studied and various parameters such as deformation behaviour, stiffness behaviour, deflection behaviour are found. Steel composite construction is well established for beams with longer spans greater than 9m span but slim floor construction creates gives the option for steel composite beam to a span range of 9-20m. Steel-concrete composite slim beams in which the steel beam encased with in concrete have the advantages of steel and concrete working together because of the bonding force between them. This new type of composite beam has many advantages, such as low floor height, fast construction. The increasing demands of long span floors but with shallow floor depth have led to the development of various composite floor systems. In conventional composite floor systems, the depth of beam section normally increases with the increases of spanning the slim floor construction of Delta Beam allow to reduce the depth of the beam resulting reduction of floor height with long span.

## II. SPECIFICATION OF BEAM PROFILE

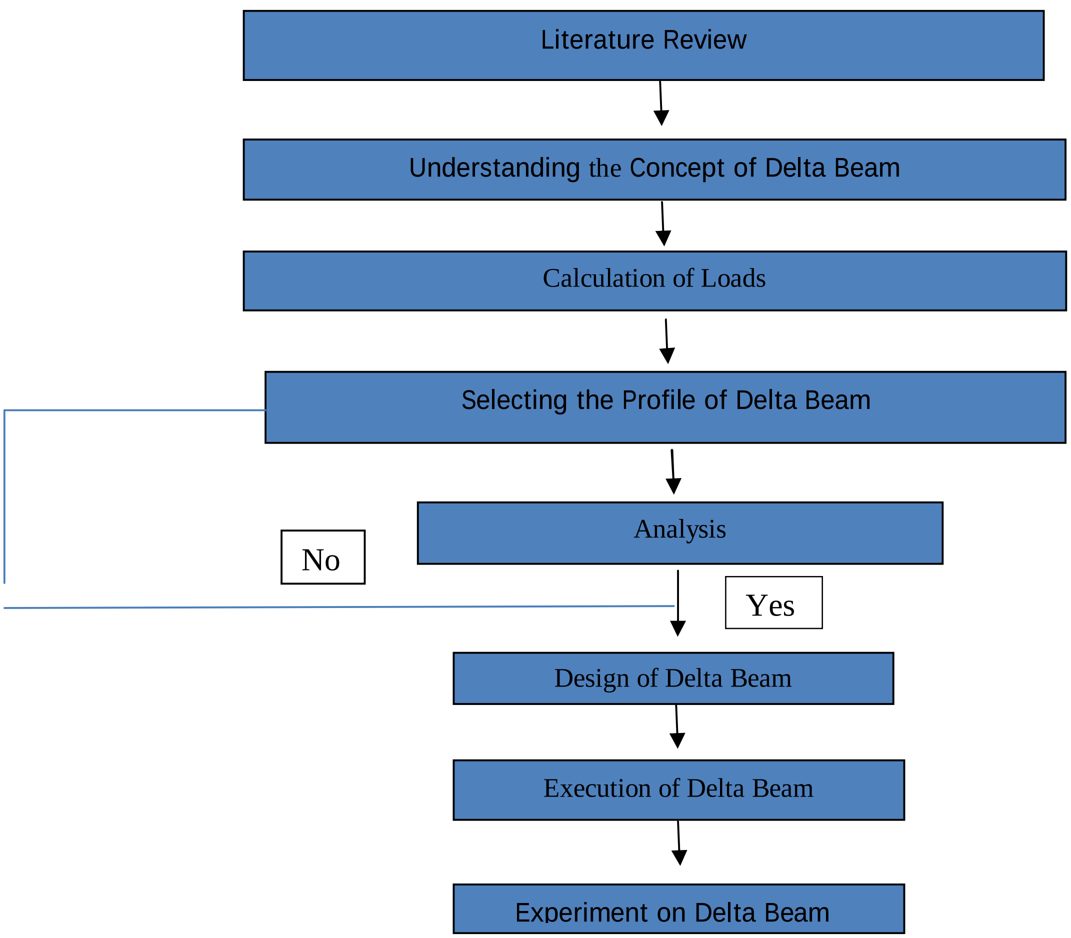
1) The trapezoidal shape of the beam plays a vital role in increasing the strength of the beam. The trapezoidal profile of the beam also increases the moment of inertia of the section and a stiffness of the beam resulting in reduction of deflection of the beam under the gravity load.
2) The web of the beam is punched with holes of 80 mm in diameter which reduces the self-weight of the beam and gives the provision of HVAC pipes.
3) Demand for long span increased due to the need of high floor space, Delta Beam gives the provision to achieve long span beam up to 20m. Slim Floor Construction result in reduction of floor to floor height
4) To Understanding the Concept of Delta Beam. To determine the behavior of Delta Beam under Static Load
5) To determining the profile of Delta Beam. Execution of Delta Beam and testing its behavior.
6) Study of Delta Beam by Finite Element Software**.**




## III. MATERIALS

| ASTM A-36 | |
|---|---|
| Physical Properties | Metric |
| Density | 7.85 g/cc |
| Mechanical Properties | Metric |
| Tensile Strengh,Ultimate | 400-550MPa |
| Tensile Strengh,Yield | 250MPa |
| Elongation at Break | 20% |
| Modulus of Elasticity | 200GPa |
| Compressive Yield Strength | 152Gpa |
| Poissons Ration | 0.26 |
| Component Element properties | Metric |
| Carbon,C | 0.26% |
| Copper,Cu | 0.20% |
| Iron,Fe | 99% |
| Manganese,Mn | 0.75% |
| Phosphorous,P | 0.04% |
| Sulfur,s | 0.05% |

## IV. METHODOLOGY



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### *A. Moment of Inertia of Delta Beam*

Moment Of Inertia of a beam plays a vital role in decreasing the deflection of the beam. The calculation of delta Beam Moment Of Inertia is shown in Table 4.1

| Moment Of Inertia Of Delta Beam | | | | |
|---|---|---|---|---|
| Notation | Formula | substitution | Values | Units |
| **$I_1$** | 1/12(bxh^3) | 1/12(177x5^3) | 1851.04 | mm^4 |
| **$A_1$** | Bxh | 177x5 | 888.55 | mm^2 |
| **$d_1$** | $Y-Y_1$ | 118.8-2.5 | 116.3 | Mm |
| | | | | |
| **$I_2$** | 1/12(bxh^3) | 1/12(5x205^3) | 3.48x10^6 | mm^4 |
| **$A_2$** | Bxh | 200x5 | 2000 | mm^2 |
| **$d_2$** | $Y-Y_1$ | 86.2-104.5 | 18.3 | Mm |
| | | | | |
| **$I_3$** | 1/12(bxh^3) | 1/12(500x5^3) | 5208.3 | mm^4 |
| **$A_3$** | Bxh | 500x5 | 2500 | mm^2 |
| **$d_3$** | $Y-Y_1$ | 86.2-2.5 | 83.7 | Mm |
| | | | | |
| **$Y_1$** | h/3((2a+b)/a+b) | | 86.2 | Mm |
| | | | | |
| **$I_y$** | $(I_1+a_1d_1^2)+2(I_2+a_2d_2^2)+2(I_3+a_3d_3^2)$ | | 45.13x10^6 | mm^4 |

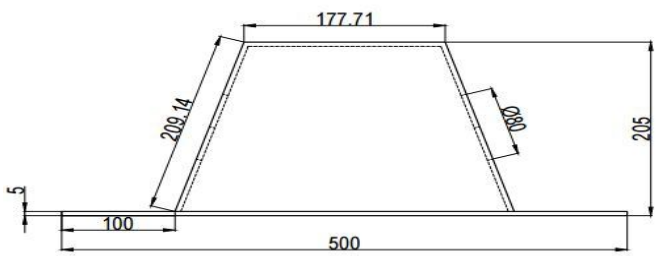


Figure.4.1 Typical cross-section of Delta Beam

### *B. Moment of Inertia of I-Beam*

Moment Of Inertia of I-Beam is calculated It is evident that the Moment of Inertia of I-Beam is comparatively low then the Delta Beam.

| Moment Of Inertia Of I-Beam | | | | |
|---|---|---|---|---|
| Notation | Formula | substitution | Values | Units |
| **$I_1$** | 1/12(bxh^3) | 1/12(500x5^3) | 5.2x10^3 | mm^4 |
| **$A_1$** | Bxh | 500x5 | 2500 | mm^2 |
| **$d_1$** | $Y-Y_1$ | 65.4-2.5 | 62.9 | Mm |
| | | | | |
| **$I_2$** | 1/12(bxh^3) | 1/12(5x195^3) | 3.08x10^6 | mm^4 |
| **$A_2$** | Bxh | 195x5 | 975 | mm^2 |
| **$d_2$** | $Y-Y_1$ | 65.4-102.5 | 37.1 | Mm |
| | | | | |
| **$I_3$** | 1/12(bxh^3) | 1/12(177x5^3) | 1.8x10^3 | mm^4 |
| **$A_3$** | Bxh | 117x5 | 885 | mm^2 |
| **$d_3$** | $Y-Y_1$ | 202.5-65.4 | 137.1 | Mm |
| | | | | |
| **$Y_1$** | h/3((2a+b)/a+b) | 65.4 | | Mm |
| **$I_y$** | $(I_1+a_1d_1^2)+2(I_2+a_2d_2^2)+2(I_3+a_3d_3^2)$ | | 30.42x10^6 | mm^4 |

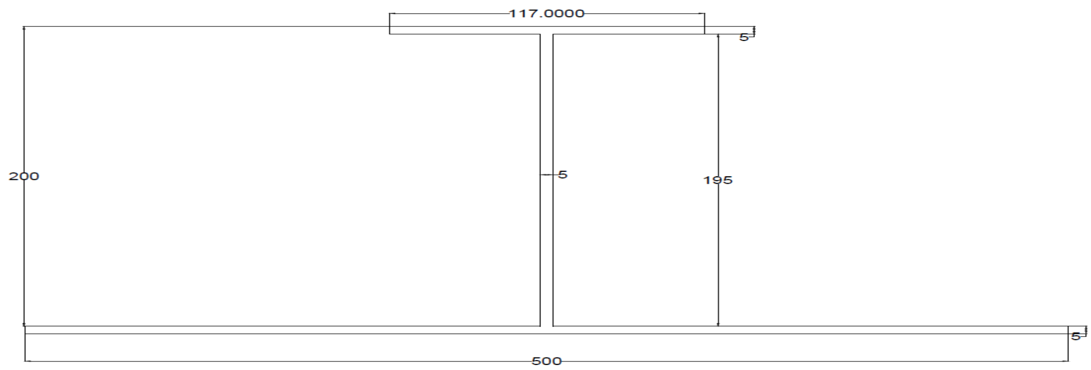


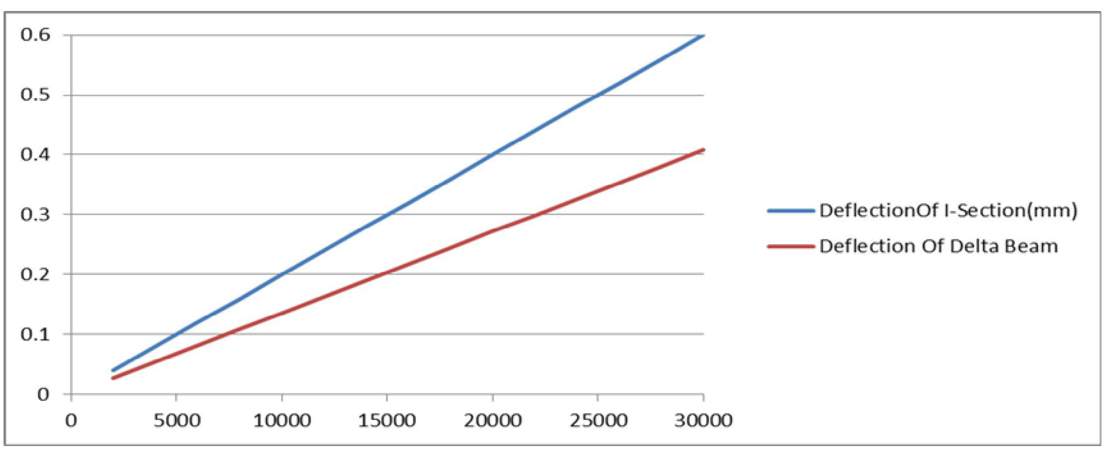

Figure.4.2 Typical cross-section of I-Beam

### *C. Deflection Of Delta Beam Vs. I-Section*

The deflection of Delta Beam and I-Beam is compared as shown in Table 4.3

$$\text{Deflection}= \quad 2x((Wa/24EI)x(3L^2-4a^2))$$

| Load(N) | Deflection Of Delta Beam(mm) | Load(N) | Deflection Of I-Section(mm) |
|---|---|---|---|
| 2000 | 0.027 | 2000 | 0.04 |
| 4000 | 0.054 | 4000 | 0.08 |
| 6000 | 0.081 | 6000 | 0.12 |
| 8000 | 0.109 | 8000 | 0.16 |
| 10000 | 0.136 | 10000 | 0.2 |
| 12000 | 0.163 | 12000 | 0.24 |
| 14000 | 0.190 | 14000 | 0.28 |
| 16000 | 0.217 | 16000 | 0.32 |
| 18000 | 0.244 | 18000 | 0.36 |
| 20000 | 0.272 | 20000 | 0.4 |
| 22000 | 0.299 | 22000 | 0.44 |
| 24000 | 0.326 | 24000 | 0.48 |
| 26000 | 0.353 | 26000 | 0.52 |
| 28000 | 0.380 | 28000 | 0.56 |
| 30000 | 0.407 | 30000 | 0.6 |



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### *D. Bending Moment Diagram of Delta Beam*

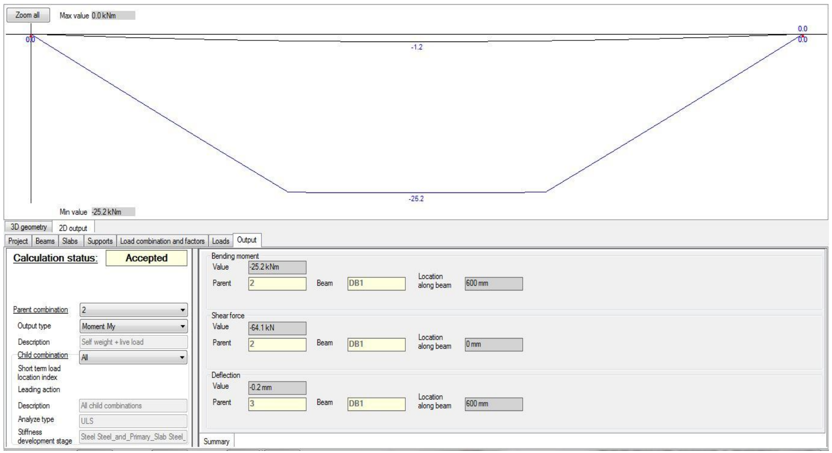



Figure.4.4 Bending Moment Diagram of Delta Beam

### *E. Shear force Diagram of Delta Beam*

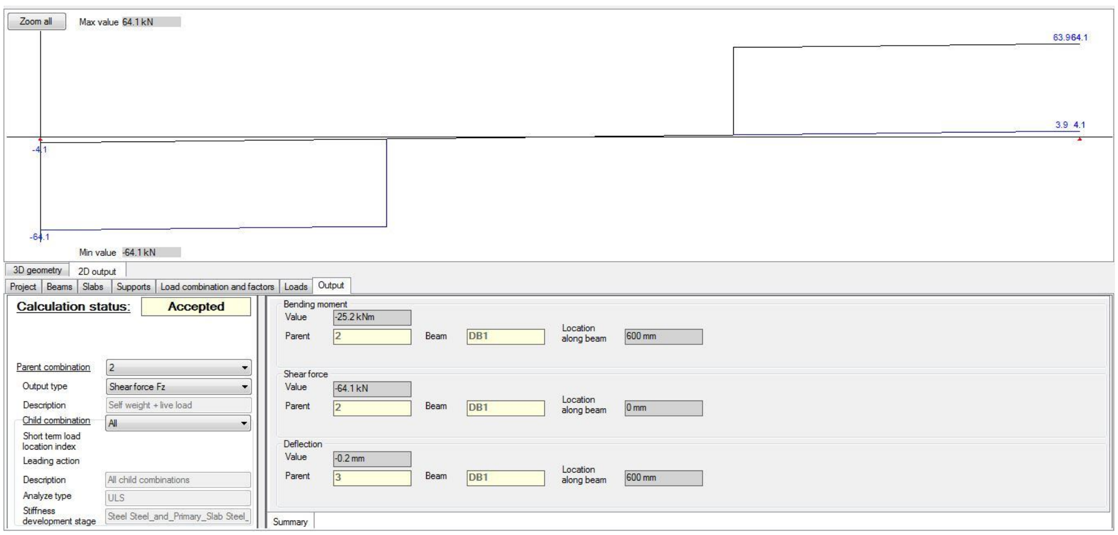
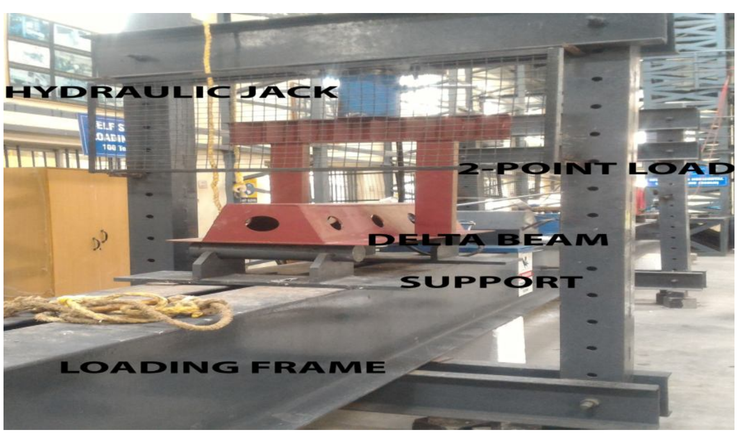
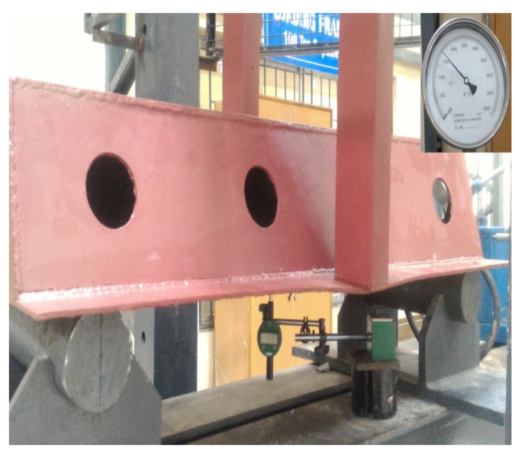



Figure.4.5 Shear Force Diagram of Delta Beam



## V. ANALYTICAL CONSIDERATION

### A. General

Following consideration for comparison of Delta Beam and I-beam are taken as follows

### B. Deflection

For Calculation of deflection the following equation is considered

$$\textbf{Deflection} = 2x((Wa/24EI)x(3L^2-4a^2))$$

Where,
W = Total Design Load(N)
a = Distance from the support to the point load (m)
EI = Flexural Rigidity (N-m)
L = Length of the specimen

### C. Sample Calculation

For Delta Beam
$I_1 = 177.5\ x5^3/12 = 1851.04\ mm^4$
$I_2 = 5\ x205^3/12 = 3.84x10^6\ mm^4$
$I_3 = 500\ x5^3/12 = 5208.3\ mm^4$
$I_y = [1851.01+[888.5[205-80.5]^2+[2[6.96\ x\ 10^6+[2000[86.2-104.5]^2+[5208.3+[2500[86.2-\ 2.5]^2-314.15500\ x5^3/12$
$= 5208.3\ mm^4$
For I-Beam
$A_1 = 500x5 = 2500\ mm^2$
$A_2 = 195x5 = 975mm^2$
$A_3 = 177x5 = 885\ mm^2$
$Y_1 = 102.5\ mm$
$Y_2 = 202.5\ mm$
$I_1 = 5.2X10^3\ mm^4$
$I_2 = 308\ X10^6\ mm^4$
$I_3 = 1.8X10^3\ mm^4$
$Y = 65.4\ mm$
$I_Y = 30.42X10^6\ mm^4$
Moment Of Inertia of Delta Beam and I-Section
$I_{Y(Delta\ Beam)} = 45.13X10^6\ mm^4$
$I_{Y(I-Beam)} = 30.42X10^6\ mm^4$
Increase in Moment Of Inertia of Delta Beam and I-Section
Percentage of increase = 49.8%

## VI. ACKNOWLEDGMENT

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