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Composite Delta Beam for Slim Floor Construction

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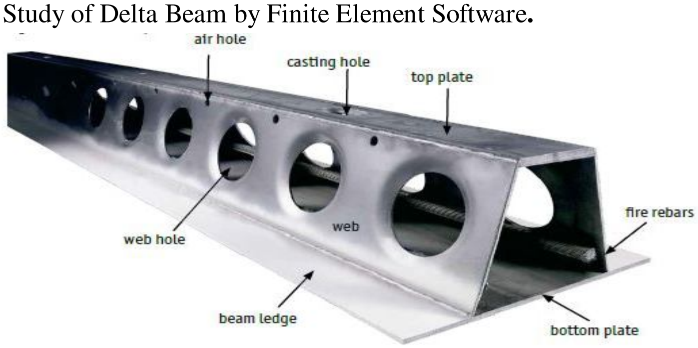
Abstract: The structural behaviour of the composite Flush Beam for slim floor as a whole has been investigated. The deformation behaviour of the structural members Steel beams with trapezoidal cross-sections and specially punched webs were developed as composite beams in slim floors. The estimation of 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

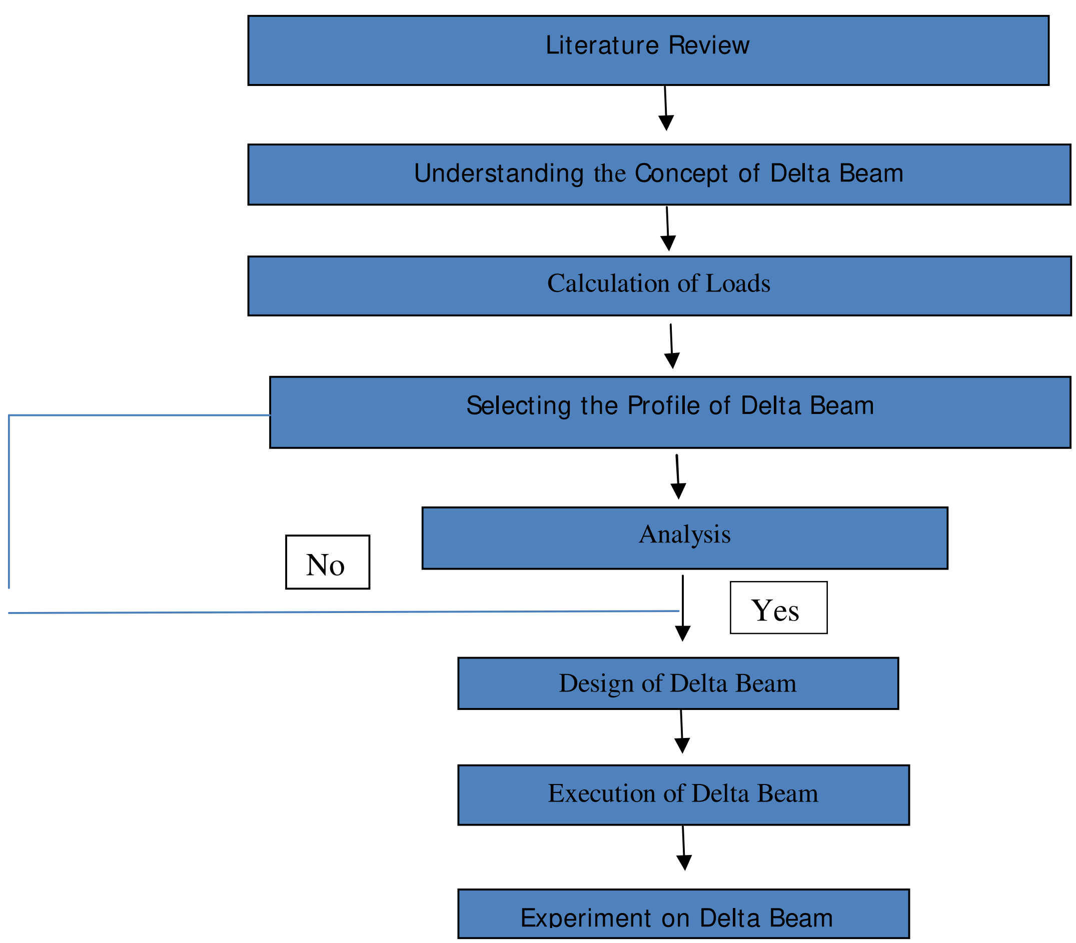
1) The trapezoidal shape of the beam plays a vital role in increasing the strength of the beam. The trapezoidal profile of the beam also increases the moment of inertia of the section and a stiffness of the beam resulting in reduction of deflection of the beam under the gravity load.
2) The web of the 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



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	$Y\text{-}Y_1$	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	$Y\text{-}Y_1$	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	$Y\text{-}Y_1$	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

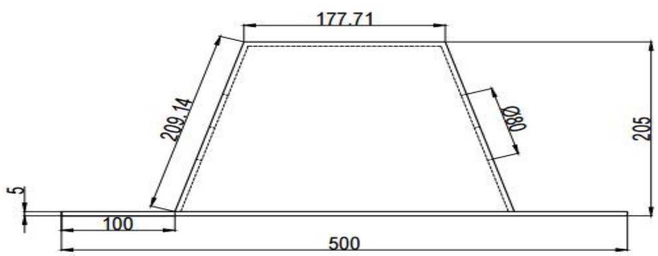


Figure.4.1 Typical cross-section of Delta Beam

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	$Y\text{-}Y_1$	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	$Y\text{-}Y_1$	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	$Y\text{-}Y_1$	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

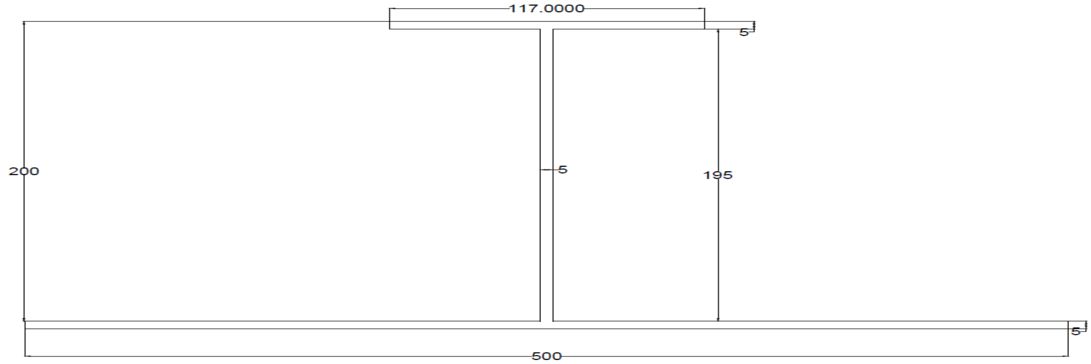


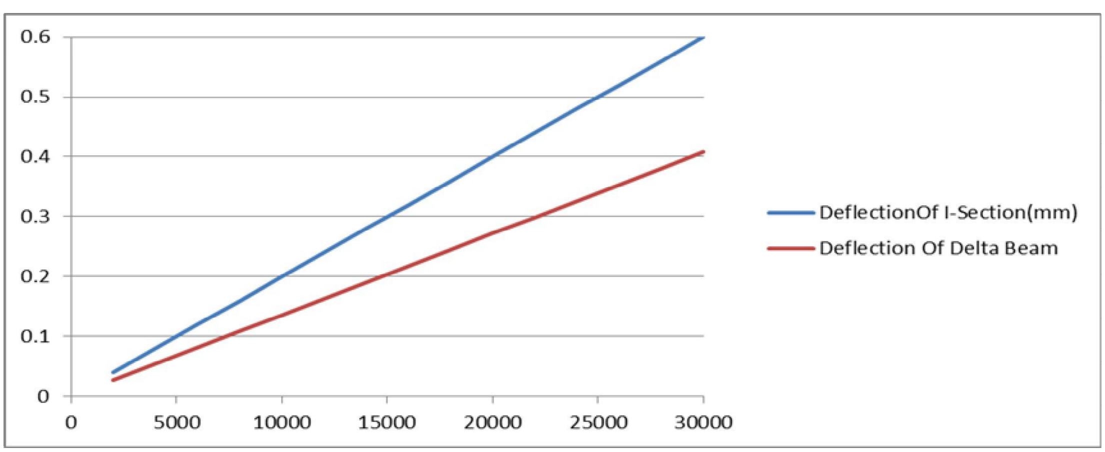
Figure.4.2 Typical cross-section of I-Beam

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

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

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

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



D. Bending Moment Diagram of Delta Beam

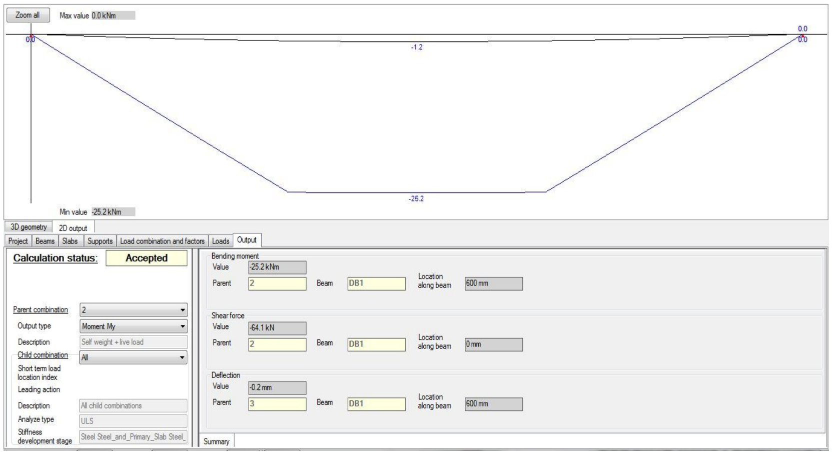


Figure.4.4 Bending Moment Diagram of Delta Beam

E. Shear force Diagram of Delta Beam

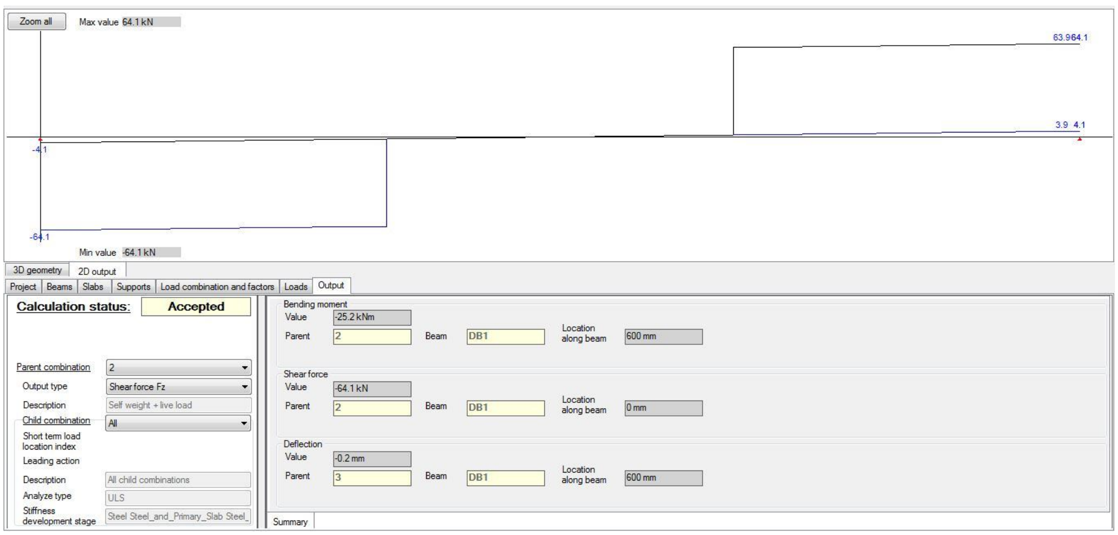
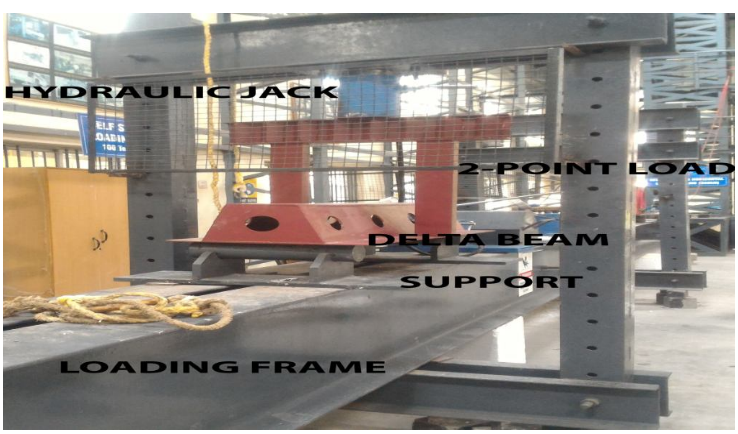
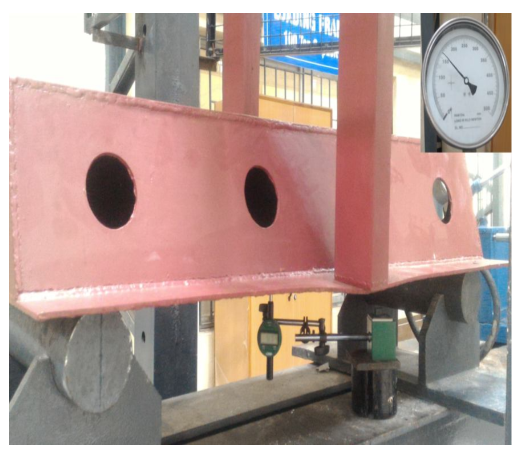


Figure.4.5 Shear Force Diagram of Delta Beam





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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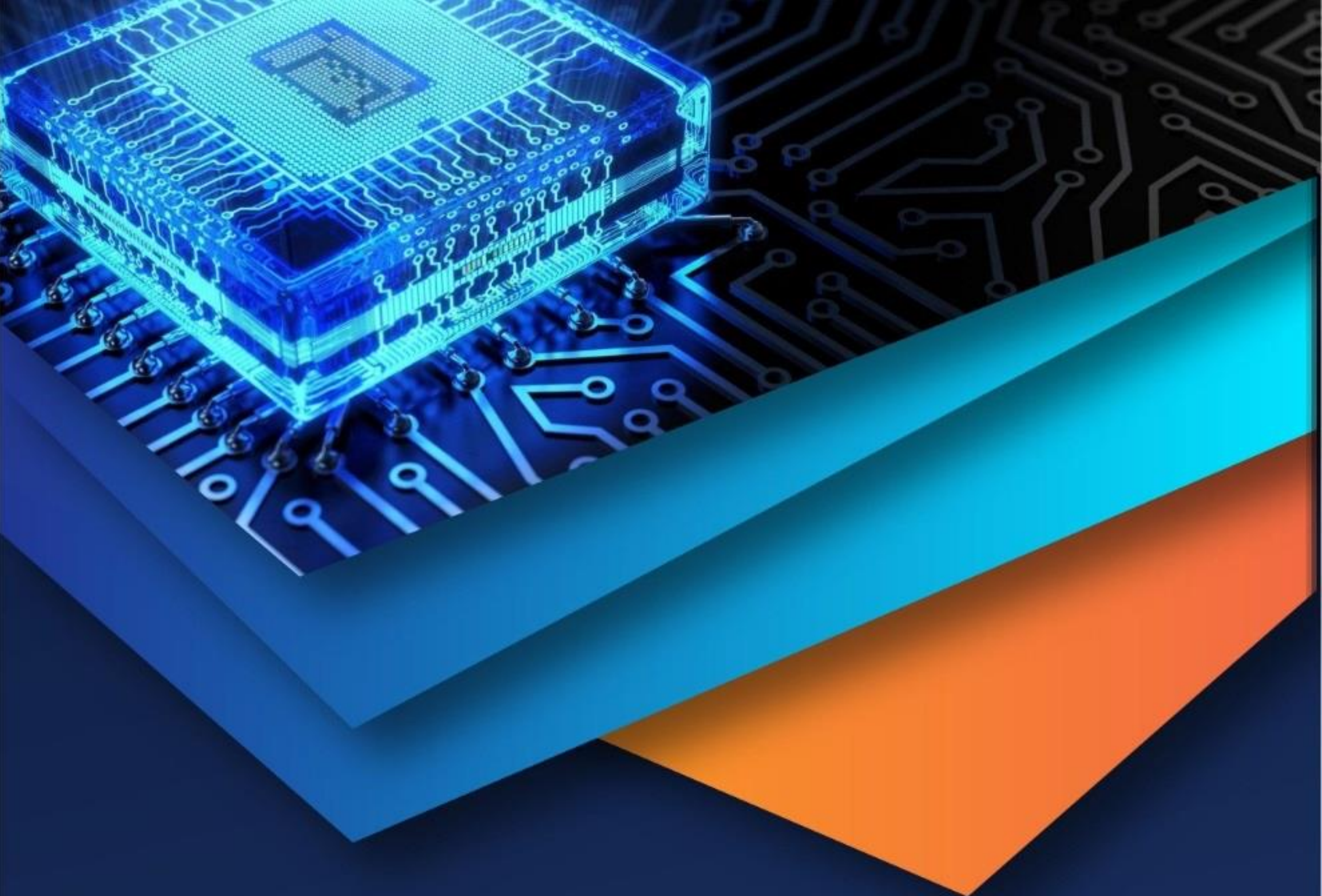

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