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Design and Analysis of Loaded Slat with Support in Both Side Clamped Boundry Condition

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Abstract — **The geometry approach is introduced for accurate stress, bending and FOS analysis of rectangular Slat with two edges fixed boundary conditions. Solid Edge V5 software and are in good agreement. Slats are used in slat conveyor system in automobile assembly line system.**

Keywords—Clamped Slat, Stress, Deflection, FOS

I. INTRODUCTION

Conveyor system is a mechanical system used in moving materials from one place to another and finds application in most processing and manufacturing industries such as: chemical, mechanical, automotive, mineral, pharmaceutical, electronics etc. There are various types of conveyor systems available such as gravity roller conveyor, belt conveyor, slat conveyor , bucket conveyor ,flexible conveyor, belt driven live roller conveyor, chain conveyor, etc. It includes loading, moving and unloading of materials from one stage of manufacturing process to another. A slat conveyor has the open links of chain drag material along the bottom of hard faced MS (mild steel) or SS (stainless steel) trough. The trough is fixed and slats are movable. The slats are the mechanical components that fixed between two strands of chain which drags the material from feeding end to the discharge end. These slats are available in different widths and lengths as per the site requirements. A small gap is made purposely between slats and trough. The slat conveyors are designed for horizontal and inclined transport of sawdust, chips, bagasse and other bulk goods. Slat conveyors are the traditional and most common means for distributing bagasse to boilers.[1]

Slat is a rectangular plate, which is an important structural part of various engineering applications such as in assembly conveying system, houses and bridge decks, pavement of airports and highways. Slat bending with various boundary conditions have been investigated for many year, but most of past methods are not suitable for all boundary conditions[2]. Timoshenko and Woinowsky-Krienger.[3] the superposition method for bending solution. Chang[4] was investigated accurate solution for slat with two edges clamped and others edges are free, which superposed six solutions, yet used trial functions. Leissa and Niedenfuhr [5] employed the method of point matching to reveal the solutions for four problems of a square plate with two adjacent edges free and the others fixed or simply supported. Some numerical methods are used for to determine the deflections of slat such as finite element method, finite difference method, integral equations, finite strip method etc.

The design of slat that deflect under edge loading and lateral loading, which neglect the shearing as well as stretching in middle surfaces of slates.

Bengston [6] to attack the problem of rectangular plates with simply supported or clamped edges, under combined axial and lateral loading.

The case of a clamped rectangular plate subjected to uniformly distributed lateral loading and. [7] forces in its plane was obtained by Chang and Conway by the so-called Marcus' method. Thus, in general, when plate deflection becomes larger the stretching of the middle plane and hence the effect of the membrane stresses should be considered.

II. DESIGN OF SLAT

A. *Design of Loaded Slat under clamped boundry condition.*

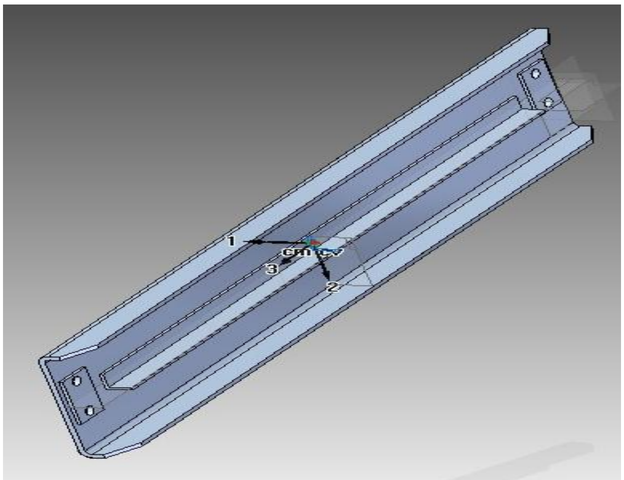

Figure 1. Solid model of slat

Problem statement –

In many structural problems, the analysis of stresses, deflections in rectangular plates subjected to two end clamped boundary conditions. Axial loading- loading in the plane of the plate

B. Units

TABLE 1 Symbols Description Units

Symbols	Description	Unit
L	Length of Slat	mm
d	Width of Slat	mm
t	Thickness of Slate	mm
W	Load	N
b	Height of Slat	mm
I	Moment of Inertia	mm^4
Mb	Bending Moment	Nmm
δ	Deflection	mm
y	Distance From Natural axis to extreme fiber	mm
a	Area of section	Mm^2
σ	Stress	Mpa

C. Theoretical Calculations

Calculations of slat deflection, stress & factor of safety.

Given data is,

Length of slat L= 1300mm, a = 1150mm

Width of slat d= 240mm

Thickness of slat t= 8mm

Height of Slat b

Load W=8000N

Material= Mild Steel (Fe410)

We going to considering slat is beam which has both end is clamped or fixed and load is acting on a center of beam.

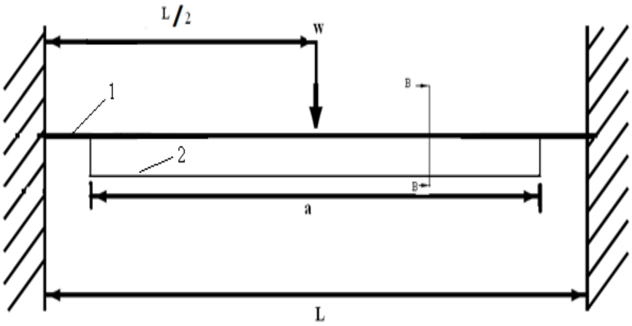

Figure 2. Both side Fixed Beam

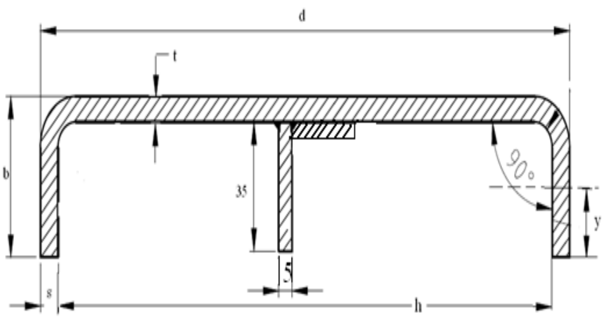

Figure 3. LS View of Slat

Where, values of

b = 55 mm d = 240mm

t = s = 8 mm h = 224

Bending moment of beam,

$$Mb = M1 + M2 \quad 1$$

$$Mb = \frac{WL}{8} + \frac{Wa}{8} \quad 2$$

$$Mb = 2.45 \text{ x } 10^6 \text{ N-mm}$$

Moment of inertia for body 1, For "C" shape

$$I_1 = \frac{(2 \text{ x } s \text{ x } b^3) + (h \text{ x } t^3)}{3} - A\,(b - y)^2 \quad 3$$

Where,

$$y = b - \frac{(2 \text{ x } s \text{ x } b^2) + (h \text{ x } t^2)}{2bd - 2h(b - t)} \quad 4$$

$$y = 55 - \frac{(2 \text{ x } 8 \text{ x } 55^2) + (224 \text{ x } 8^2)}{(2 \text{ x } 55 \text{ x } 240) - 2 \text{ x } 224(55 - 8)}$$

y = 43.26mm

Area = A,

A = bd - h (b-t)

A = (55 x 240) – 224(55-8)

A = 2672mm

So therefore,

$$I_1 = 557.29 \text{ x } 10^3 \text{ mm}^4$$

Moment of inertia for body 2, For "L" shape

$$I_2 = \frac{1}{3}\left[ty^3 + a\left(a - y^3\right) - \left(a - t\right)\left(a - y - t^3\right)\right] \quad 5$$

Where,

area a = t (2a – t) = 5 [(2x5) – 5] = 325 mm^2

$$y = a - \frac{a^2 + at - t^2}{2(2a - t)} \quad 6$$

Therefore,

$$I_2 = 36.35 \text{ x } 10^3 \text{ mm}^4$$

Total moment of inertia, I

$$I = I_1 + I_2$$

$$I = 557.29 \text{ x } 10^3 + 36.35 \text{ x } 10^3$$

$$I = 593.64 \text{ x } 10^3 \text{ mm}^4$$

Deflection of slat, δ

$$\delta = \frac{WL^3}{192\,EI} = 0.77 \qquad 7$$

Stress in slat, σ

Wkt, $$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R} \qquad 8$$

Therefore, stress ,

$$\sigma = \frac{M}{I} y$$

$$\sigma = \frac{2.45 \text{ x } 10^6}{593.64 \text{ x } 10^3} \text{ x } 43.26$$

$$\sigma = 178.53 \text{ N/mm}^2$$

Analysis of Loaded Slat With Support Under Two Sided Clamped Boundary Condition

Solid edge is modeling tool, which is easy to use to develop the parts. Solid edge is a product development tool, gives the flexibility and parametric design. In this project work the slat model is developed in solid edge modeling tool.

The clamped slat simulation process is carried out in solid edge simulation express for separate parts, to Femap for defining and analyzing the whole system. In simulation process gives the values of stress, deflection and factory of safety.

TABLE 1 Part Properties

Part Name	240x55x8thkx1300lx35x35x5angle.par
Mass	29.512 kg
Volume	3767634.481 mm^3
Weight	289.216 n

TABLE 2 Material Properties

Material Name	steel, structural
Mass Density	7833.000 kg/m^3
Young's Modulus	199947953 Kpa
Poisson's Ratio	0.290
Thermal Expansion Coefficient	0.0000 /c
Thermal Conductivity	0.032 kw/m-c
Yield Strength	262000.766 Kpa
Ultimate Strength	358527.364 Kpa

TABLE 3 Load and Constraint Information
Load Set

Load Set Name	load 1
Load Type	Force
Number of Load Elements	2
Load value	8000.0

TABLE 4 Constraints

Number of Constrained Faces	8

TABLE 5 Study Properties

Mesh Type	Tetrahedral mesh
Number of elements	9,373
Number of nodes	19,191
Solver Type	Nastran

TABLE 6 Stress Results

Type	Extent	Value	X mm	Y mm	Z mm
Von Mises Stress	Min.	6.397e-003 kpa	-70.39	32.93	-4.35
	Max.	1.751e+005 kpa	5.29	70.00	-4.35

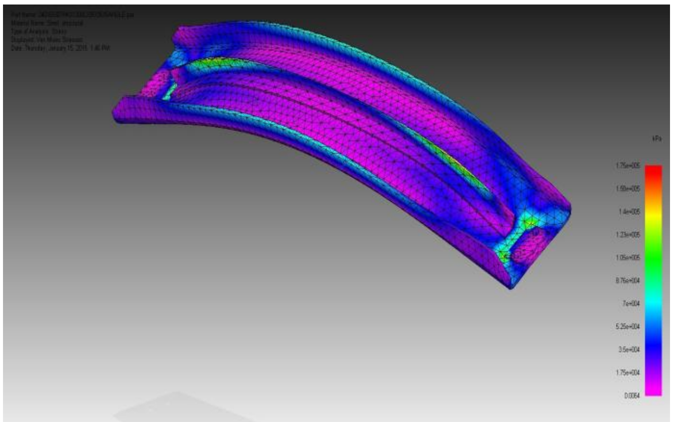

Figure 3 Stress Analysis

TABLE 7 Displacement Results

Type	Extent	Value (mm)	X mm	Y mm	Z mm
Resultant Displacement	Min.	0.00e+000	-16.78	47.07	8.65
	Max.	1.39e+000	12.37	651.61	0.65

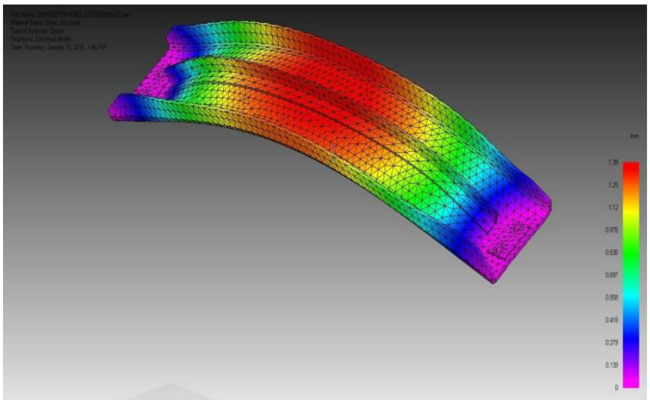

Figure 4 Deflection Analysis

TABLE 8 Factor of Safety

FOS Value	1.496

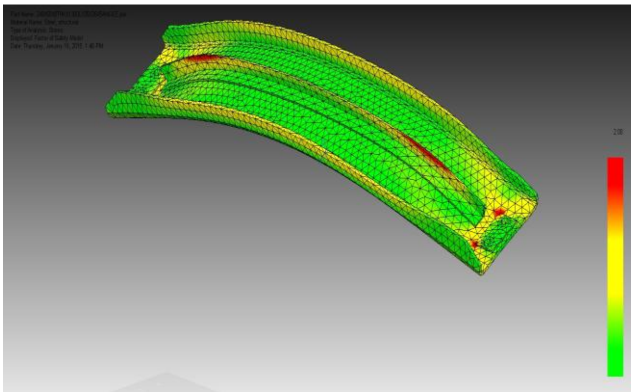

Figure 5 Factor of Safety Result

D. *Results and Discussions*

To comparing both results which are finding out by theoretically and by analytically. The both result are given below. The percentage of results variation was observed and are in permissible range.

TABLE 9 Displacement Results

	THEORETICAL RESULT	ANALYTICAL RESULT
Stress	1819.95 kg/cm^2	1783.89 kg/cm^2
Deflection	0.77 mm	1.39 mm
FOS	2.29	1.496

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