



An Investigation On The Behaviour Of Laced Column Structures In Order To Develop Resistance To Buckling Failure

Mr. Vishnu A.J

B.Tech Student

Musaliar College of Engineering

INTRODUCTION:

Laced column system is a sort of built-up column utilised for various unique industrial building designs, such as cladding posts or crane girder support columns. These members are designed for huge, tall buildings with lengthy compression members that are subjected to strong loads and produce comparatively light constructions with substantial inertia. In general, columns of this sort are lighter and easier to welded or bolted with gusset, lowering fabrication costs and making installation easier. Lacing arrangements (e.g., N-shape, V-shape, or X-shape) may affect fabrication complexity, however N-shape and V-shape are less expensive and more widely utilised. The overall cross-section of a conventional built-up column is the same everywhere. For example, if a wide-flange column is strengthened by welding plates between the flange points to form a box, the box will be the same all the way down the column. Laced columns, on the other hand, are a type of built-up column in which the position of some of the little parts varies throughout the length of the column. The typical layout, as seen in the vertical members above, is to connect two primary parts, usually channels, with a series of double-diagonal connectors. The total result resembles lacing up a tall boot, which is how the term came about.

NEED OF THE STUDY:

When those working in steel construction today look at laced columns, they notice how much labour is required to fabricate and assemble all of those small connection pieces for what appears to be a small gain.

Laced columns are weaker than substantially built-up columns, so they should only be utilised in regions that are not overly loaded. The top four stories of many structures feature the same size channels used in built-up columns, with lacing on the top two levels and single plates on the third and fourth floors down. Laced columns expose the built-up column box section's internal space, which might be good or harmful depending on your confidence in your ability to paint within. The geometry of interwoven columns is harder to figure out, the quickest way to determine the dimensions is through trigonometry and may have been beyond capabilities of modest ironworks.

LITERATURE REVIEW:

Razdolsky (2021) The study proposes a strategy for solving the laced column buckling issue as a statically indeterminate structure without examining high-order determinants. The two-point boundary value problem for a differential equation system is used to solve the flexural and torsional buckling problems of laced columns. Analysis of the fourth order determinant for columns with any degree of static indeterminacy yields the value of Euler critical load. The solution is based on the starting value technique

Svensson et al. (2021) The sensitivity of interwoven columns to geometrical defects is explored, with the imperfection consisting of both local and overall geometrical imperfections. The linear elastic issue, as well as the linear elastic-ideally plastic problem, are solved using a simple numerical algorithm. In the latter situation, the collapse load is approximated by the load, causing the structure to yield. The linear-elastic column is demonstrated to behave almost like a shell after attaining the collapse load, and so must be expected to be sensitive to flaws. When the two critical Euler stresses and the yield stress all coincide, the relative loss in capacity of the linear elastic-ideal plastic column is greatest

MODELLING, MESHING AND LOADING:

The laced column was modelled using ANSYS Workbench software. All materials were considered isotropic. Non-linear material simulation of ANSYS was used for the steel. The structural steel was treated as a multi-linear isotropic hardening material. Fig 1 illustrates the 3D geometry creation in ANSYS 2021.

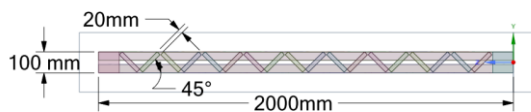


Fig No 1: geomertic loading

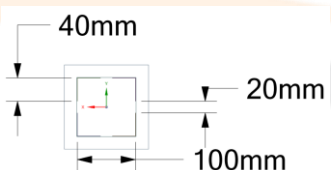


Fig No 2: cross-sectional dimensions

LOADING AND BOUNDARY CONDITION:

A: Static Structural
 Static Structural
 Time: 1. s
 A Force: 1000. N
 B Remote Displacement 2
 C Remote Displacement

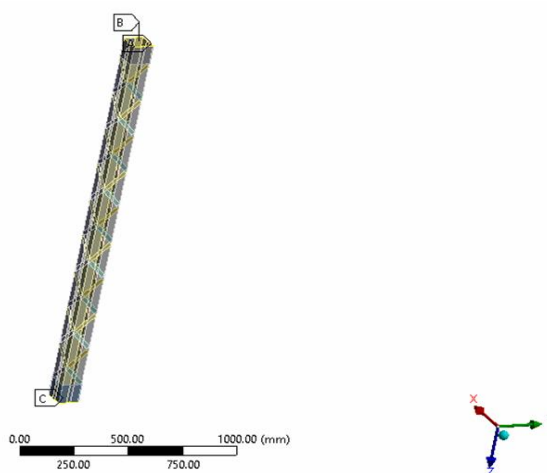


Fig No 3: conditions

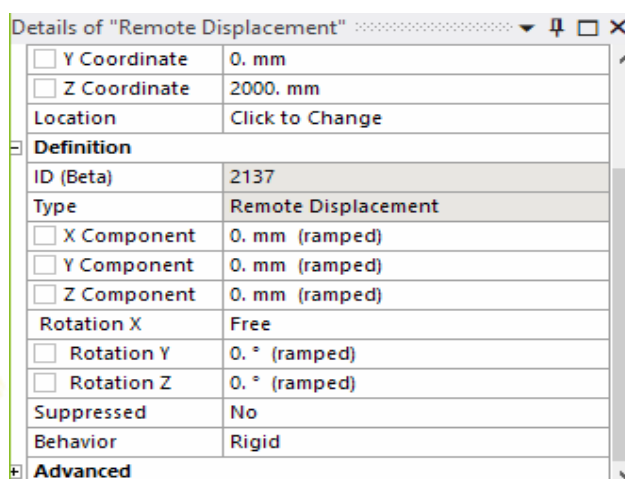


Fig No 4: details of remote displacement

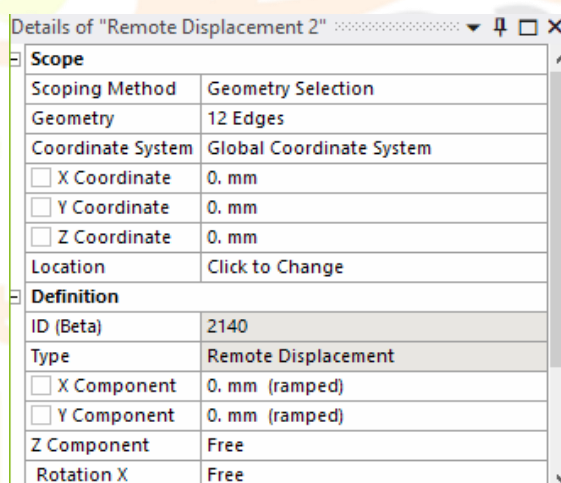


Fig No 5: details of remote displacement

RESULTS AND DISCUSSION:

From Ansys, the buckling load is obtained for different models by varying the batten width. By conducting this parametric study, the width of the batten with best performance is optimised. Thus, the performance of laced columns with different batten width is analysed and the one with better performance is proposed. The total deformation and equivalent stress is obtained by applying static structural loading and eigenvalue buckling loading. The mode of failure in the analysis is by local buckling of the column. Fig 3.12 shows total deformation of the laced column after applying static loading.

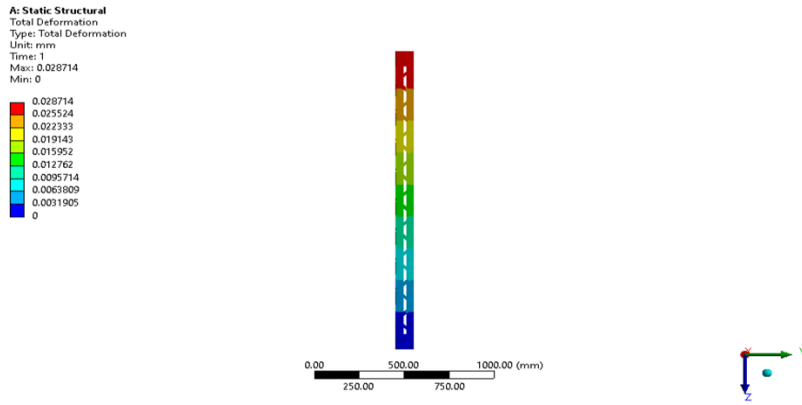


Fig No 6: total deformation(without intermediate batten)

Table No 1: Critical load for different batten width

Batten width (mm)	Critical load (kN)
18	22.18712
20	24.00734
22	24.96194
24	25.38047
26	26.41201
28	26.66273
30	26.58528

VARYING BATTEN PLATE WIDTH:

The effect of local buckling is studied by changing the batten thickness. The batten thickness is varied between 18mm to 30mm. The critical loads obtained for different batten widths are shown in table.

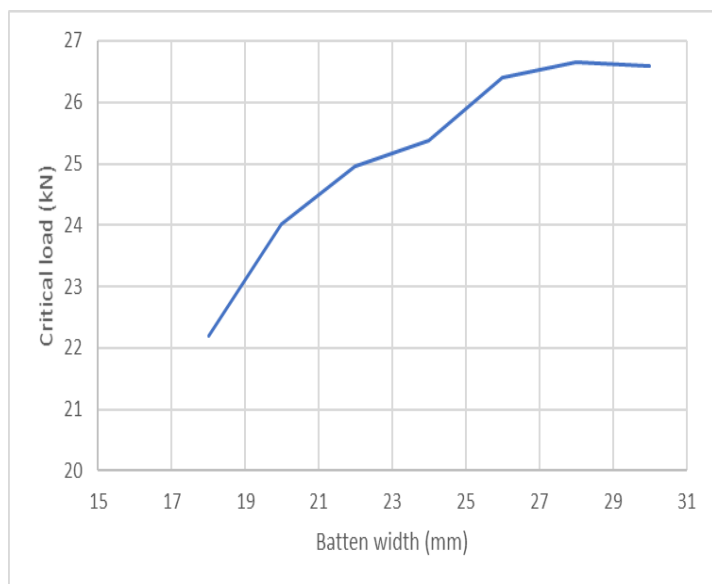


Fig No 7: batten width vs critical load

PROVIDING INTERMEDIATE BATTEN PLATES:

In this case, intermediate battens are provided to the laced structure to increase the load carrying capacity. Adding batten plates in the weaker sections, where local buckling happens increased the load-carrying capacity of the beam.

Table No 2: percentage change from initial design

Batten Width (mm)	Critical load (kN)	Percentage change from the initial design
18	22.18712	-11.2657
20	24.00734	-3.98599
22	24.96194	-0.1682
24	25.38047	1.50564
26	26.41201	5.631139
28	26.66273	6.633853
30	26.58528	6.324097

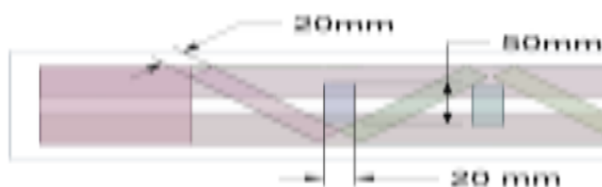


Fig No 8:providing intermediate batten plates

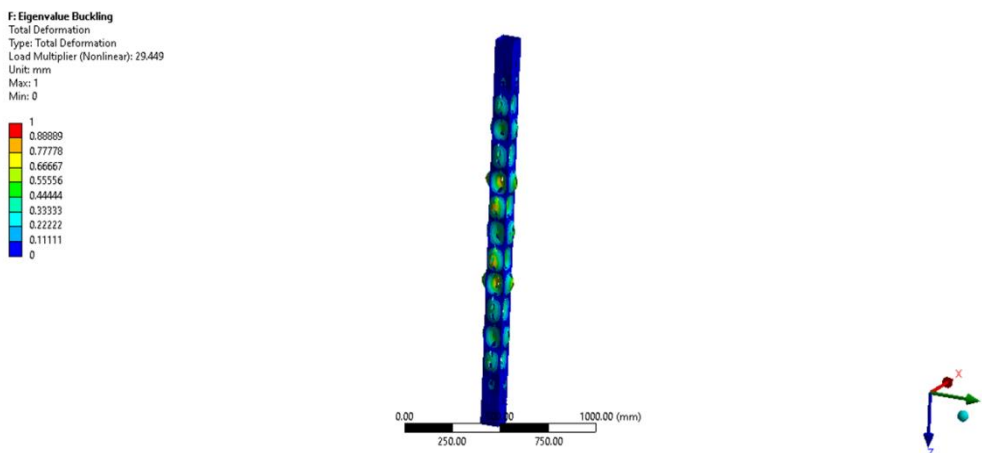


Fig No 9: total deformation

RESULT INTERPRETATION:

The varying batten width and the corresponding critical load of modified column is given in table along with the percentage change from the initial design.

Table No 3: Results of modified design

Thickness of batten placed in the intermediate position (mm)	Buckling load (kN)	Percentage change from the initial design (%)
0.4	27.04132	8.165269017
0.5	27.77813	11.11253379
0.6	28.61091	14.44364169

0.7	29.4489	17.79561734
0.8	30.2477	20.99079801
0.9	30.93025	23.72100624
1	31.49279	25.97114049
1.1	31.76678	27.06711192
1.2	31.98778	27.95111059

CONCLUSIONS:

An extensive numerical investigation has been carried out to study the role of batten width in the load carrying capacity of laced column structures. The project aimed to find out the ways to increase the load-bearing capacity of laced structures without compromising its height requirements at a reasonable cost, which can be later useful for future industries. The parametric study is conducted by varying the width of battens of the lacing plates from 18mm to 30mm. From the analysis, the following conclusions were made. The load carrying capacity of laced columns, susceptible to fail by local buckling, is strongly influenced by the width of the battens provided. There are two cases considered in this project. In the first case, the batten width is varied and its effect on the load carrying capacity of the laced column is studied. It is observed that, by increasing the batten width, the critical buckling load increases. Seven batten widths are considered for the simulation such as 18mm, 20mm, 22mm, 24mm, 26mm, 28mm, and 30mm. It is observed that, the critical load increases up to batten width 28mm and there after it converges. The mode of failure is by local buckling. From the parametric study, the optimum width of batten was obtained as 28mm. The maximum load carrying capacity observed is 26.66 kN, i.e., for 28mm batten width. Providing intermediate battens increased the load carrying capacity significantly.

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