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Research Article

New Product Design and Analysis for Structural Pedestal to withstand Heavy Static Loading with improved Movable Conditions

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Abstract

The Present Paper focus on the concept to design and analyze a pedestal of longitudinal I-section fabricated to carry vertical tension forces and shear forces, respectively. A Model is proposed to analyze shear compressive force transfer from the overhead load to pedestal and to design the required amount of shear cross section and also perform the cost estimation. If the structure is improperly designed or fabricated, or if the actual applied loads exceed the design specifications, the device will probably fail to perform its intended function, with possible serious consequences. A well-engineered structure greatly minimizes the possibility of costly failures and improved maneuverability by providing Nylon wheels under the structure.

Keywords: *Pedestal, Tension Force, Shear force*

1. Introduction

1.2. Pedestal mounting design

The Pedestal Mounting is important equipment for supporting and transporting for lightening the intensity of labour and improving the operating efficiency during assembly of Locomotive. (Hu Y.M., *et al*, 2009) An object here in this case a Locomotive is vertically using a movable crane and mounted on to this Pedestal, which is mainly held at the right position under the locomotive where the markings are specified for the section used for supporting and transportation between fixed span in workshop of factories, storehouse, and in the freight yard of railway and port. The deadweight of a locomotive is an important economic indicator for measuring the performance of the Pedestal. (Wang, *et al*, 2009)

Therefore, on the premise of the reliability service of the Locomotive, its deadweight should be lightened as far as possible. As is known to all, the main structure of locomotive consists of various systems which together make up the locomotive's dead weight is supported until it is mounted onto the Bogie.(Abdullah Waseem *et al* , 2013).

A pedestal is used to carry the loads from metal columns through the flat face and I-section to the footing when the footing is on flat level ground. The purpose is to avoid possible corrosion of the metal from the soil. Careful welding over the footing and around the pedestal will be necessary to avoid ingressions and floor cracks. If the pedestal is very long, a carefully compacted stiffeners will provide sufficient lateral support to control buckling. The problem is to identify the unsupported length correctly when the member is embedded to the foot. The code allows both reinforced and unreinforced pedestals. Generally the minimum percentage of steel for columns of 0.01% carbon should be used even when the pedestal specifies gross column area—that is, no area reduction for column optimization. Critical factor is that vertical steel should always be designed to carry any tension stresses from moment or uplift is not designed as a reinforced column-type element. Rather, when the pedestal is designed as an unreinforced member, the minimum column percent steel is arbitrarily added.

When steel base plates are used, this reinforcement should withstand from the pedestal top in order to minimize point loading on the base plate. Steel plate should be liberally added at the top to avoid spalls and to keep the edges uniformly loaded. (S. H. Masood, *et al*, 2006) Pedestals are usually considerably overdesigned, since the increase in materials is more than offset by reduced design time and the benefit of the accrued safety factor. Pedestals can usually be designed as short columns because of the lateral support. They may be designed for both axial load and moment. For the rather common condition of the pedestal being designed as a simply supported column element interfacing the superstructure to the footing. (Nursalbiah Nasir, *et al*, 2011).

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2. Properties of structural steel (S355J2+N)

Quality	**S355J2** (Fe 510 D)	*Technical card*
According to standards	**EN 10025-2: 2004**	*Lucefin Group*
Number	**1.0577**	

Chemical composition

C% max	**Si%** max	**Mn%** max	**P%** max	**S%** max	**N%**	**Cu%** max	
0,20 a)	0,55	1,60	0,025	0,025		0,40	**Cast** analysis
0,23 a)	0,60	1,70	0,035	0,035		0,45	**Product** analysis
FF deoxidation method - ful y kil ed steel							S355J2 n° 1.0579
a) max 0.22 by ladle analysis, max 0.24 of the product for thickness > 30 mm up to 100 mm							P% - S% max 0.030
a) for nominal thickness > 100 mm, C content to be agreed							cast analysis

Temperature °C

Hot-forming	**Supply state**	**Soft annealing**	**Isothermal annealing**	**Temperature values are valid for analysis close to:**		
				C%	Mn%	Si%
1100-850	natural state	700 air (HB max 180)		~ 0.18	~ 1.20	~ 0.30
In some cases, the piece can be normalized and tempered or quenched and tempered				**Pre-heating welding**	**Stress-relieving after welding**	
Normalizing and tempering	**Quenching and tempering**	**Stress-relieving**	**End quench hardenability**	100	slow cooling	
920 air 550-650 air	880-900 water 550-650 air	50° under the temperature of tempering				
				AC1	**AC3**	**MS** **Mf**

Mechanical properties

Hot-rolled EN 10025-2: 2004 **S355J2**

Testing at room temperature Kv –20 °C

size mm		**R**	**size** mm		**ReH**	**size** mm		**A% L**	**A% T**	***HB***
from	to	N/mm2	over	to	N/mm2min	over	to	min	min	*for information*
	3	510-680		16	355	3	40	22	20	*154-208*
3	100	470-630	16	40	345	40	63	21	19	*141-192*
100	150	450-600	40	63	335	63	100	20	18	*135-178*
150	250	450-600	63	80	325	100	150	18	18	*135-178*
250	400	450-600	80	100	315	150	250	17	17	*135-178*
			100	150	295	250	400	17	17	
			150	200	285	over	to	**Kv** L - 20 °C a) J min		
Mod. of elasticity GPa			200	250	275		150	27		

3. Procedure

3.1 Modeling

Pedestal has been modeled in CATIA V5

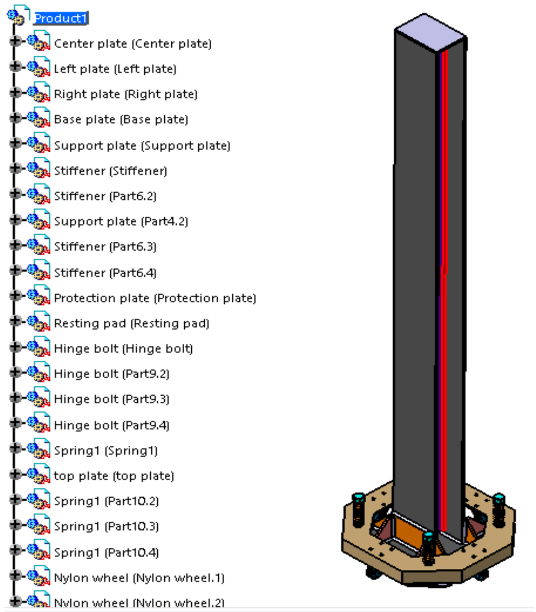

Figure 1 Catia Model (Complete Pedestal)

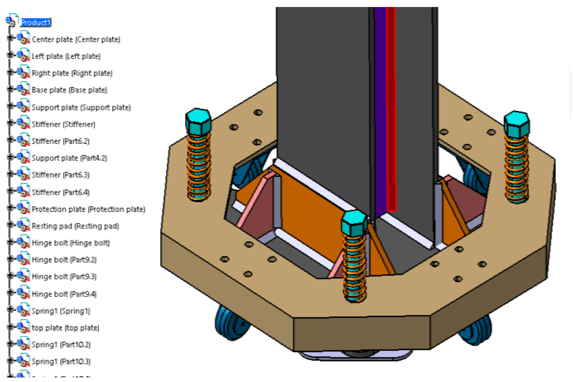

Figure 2 Catia Model (Bottom Part of Pedestal)

3.2 Analysis

3.2.1 Structural Analysis

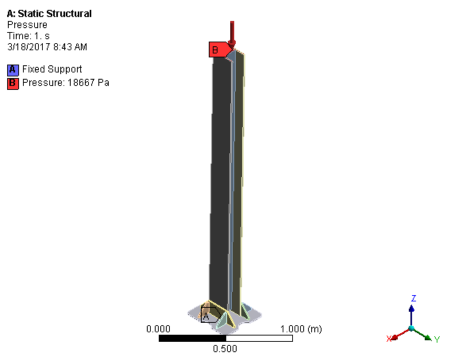

Figure 3 Load acting on pedestal (static analysis)

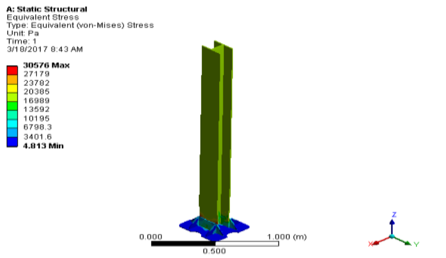

Figure 4 Variation of stress in pedestal

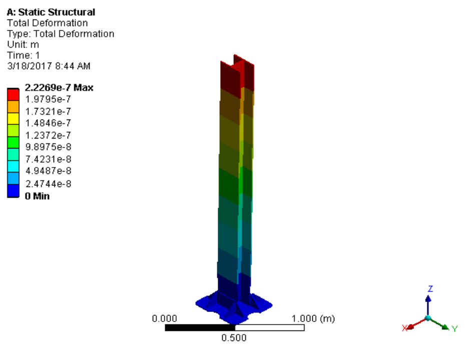

Figure 5 Variation of deformation in pedestal

3.2.2 Model Analysis

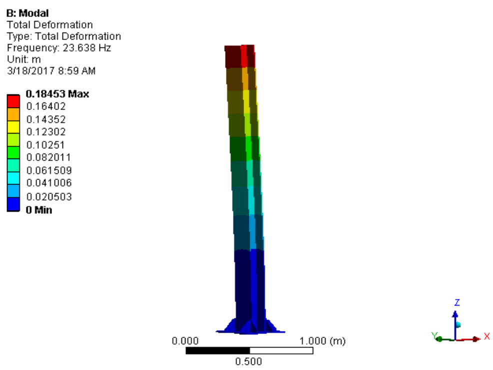

Figure 6 Variation of deformation in pedestal under Model Analysis at given frequency

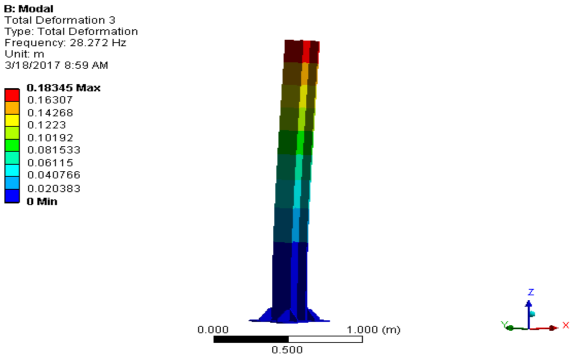

Figure 7 Variation of deformation in pedestal under Model Analysis at given frequency

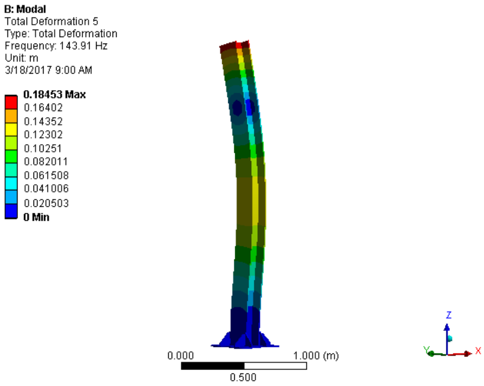

Figure 8 Variation of deformation in pedestal under Model Analysis at given frequency

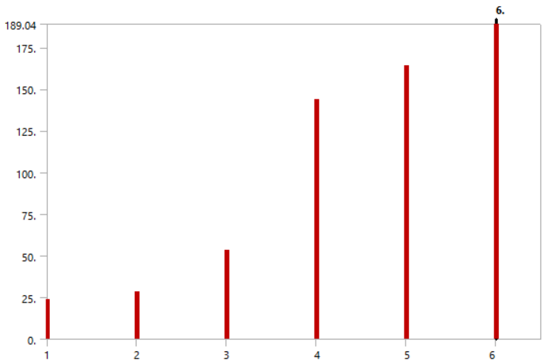

Figure 9 Chart indicating Frequency at each Node

Conclusion

1. A computer-based design of 2D and 3D steel frame Pedestal structures to support the locomotive during assembly phase is developed

2. Analytical descriptions have been obtained for the welds & used in welding to fabricate a I-section with the effective buckling length factor for columns is reduced by introducing extra stiffeners and ribs and welding through the frame.

3. With the concept of Nylon wheels, mobility is achieved and the structure could be relocated to multiple locations and can be used where ever necessary on shop floor.

4. Simulation is also shown and the stresses are values are found to be within the elastic limit of materials used.

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