

Mast Pre-tensioning by means of tie rods

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Lift Technologies 



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The problem

One of the main problems in the material handling world is sampling and positioning. In particular, when handling large and heavy loads at considerably high lift heights, the mast may suffer from structural deformations which sometimes can cause it to be unfit for its use. To reduce these disadvantages there were two solutions so far: oversize the resistant section, with consequent increase of the masses and related costs, or decrease the load with resulting performance drop of the equipment.

The solution

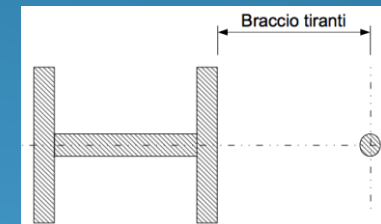
The proposals of either increasing the mast resistant section or reducing the nominal load can obviously not represent feasible solutions because they do not solve the problem and in fact they even reduce the structure performance. Instead, a solution could be to apply a system of forces able to contrast these deformations and keeping them within predetermined limits at the same load conditions. This would serve a dual-purpose: either increase the nominal load or decrease the frontal deflection using the same resistant section. Also, this system would avoid having to derate the mast for exceeding the maximum permissible constraint on the frontal deflection ($1/80 * \text{elevation}$).

How to implement the solution

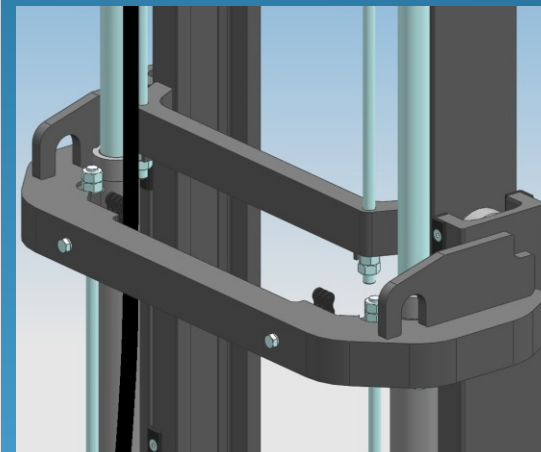
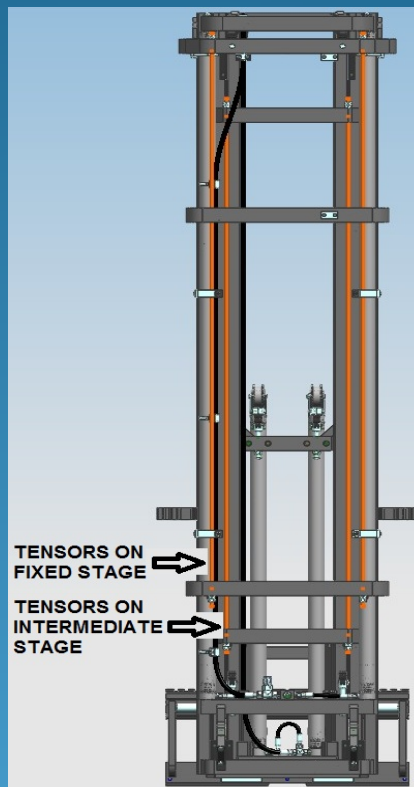
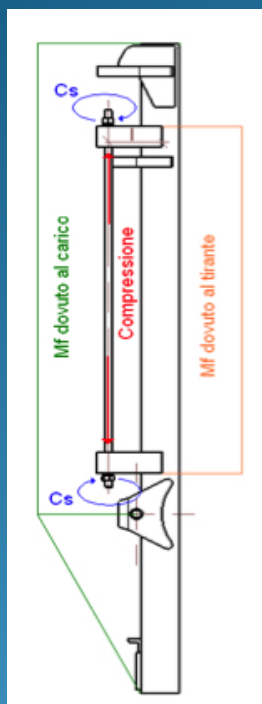
For this reason if we apply an elastic deformation to the mast, in the opposite direction to that of the load, this will lead to reduce the overall deformation each time the mast lifts at every elevation. This is possible thanks to a number of threaded rods made integral to the stages by means of welded brackets and hexagonal nuts to which is impressed a torque (Cs) in order to generate a stress state (preload) within the tie rod itself and consequently in the supporting structure.

The preload is proportional to the:

- torque (Cs);
- tie rods' resistant section;
- elastic modulus of the material forming the tie rods;
- distance between profile and tie rods (braccio tiranti).



Below you can see some images showing the construction scheme of the solution and a practical example of a three-stage mast equipped with tie rods.

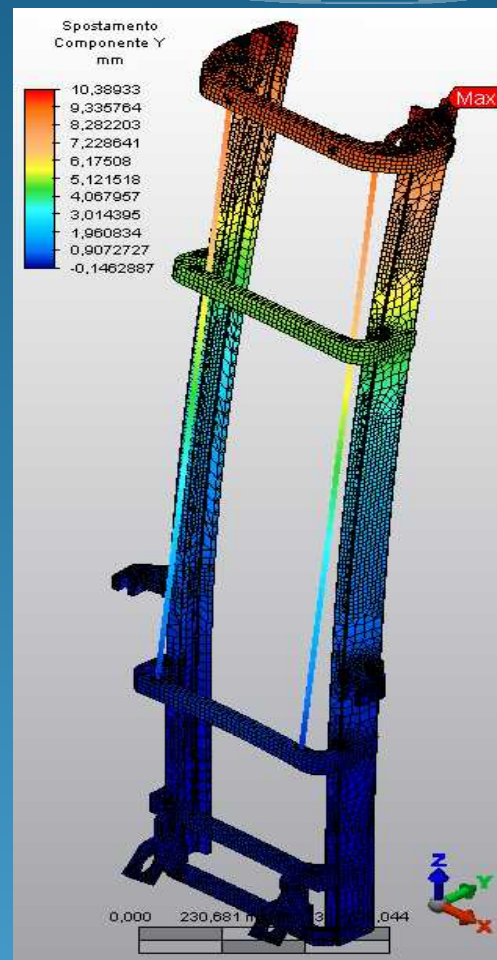
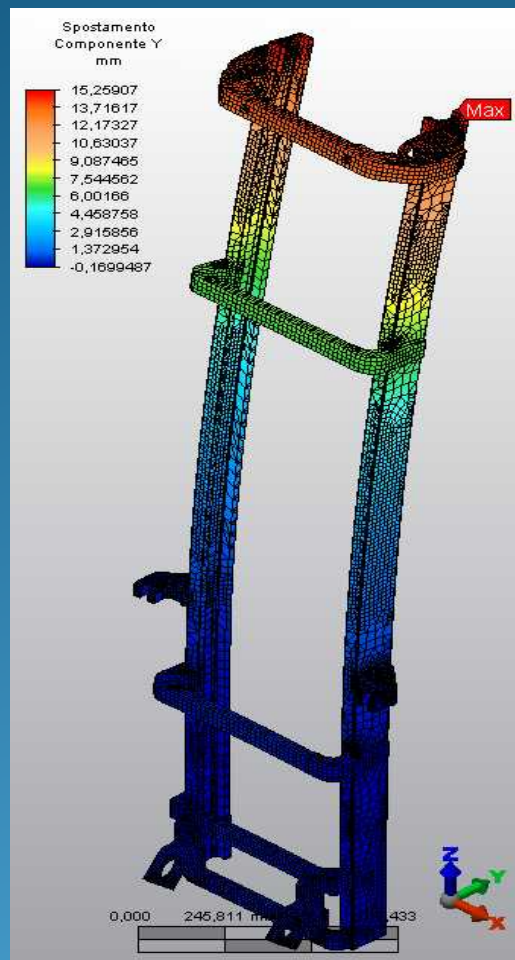


COMPARISON BETWEEN A STANDARD AND A -ED MAST

To evaluate the benefits in terms of maximum deflection induced by pre-tension, let us analyse the fixed stage of the triplex mast shown earlier.

Subject to the nominal load, the maximum deformation in the two possible system configurations is as follows:

| | Max deflection [mm] |
|--|---------------------|
| Standard configuration | 15 |
| Pretensioned configuration (preload=7960 N) | 10 |



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Looking at the results summarised in the graph, we can better perceive the **performance increase** produced by the mast tensioning of **50%**:

With the blue line you can see that the deformation in the standard configuration is higher than that in the pre-tensioned configuration shown in black. In red, instead, it is displayed the deformation in the opposite direction than the previous two lines due to the preload alone carried on the structure.

