Analysis and Optimization of 270° Jib Crane Deflection: A Review

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Abstract— Jib cranes are widely used in industrial facilities all over the world. A typical jib crane consists of a top beam which is rotating around a fixed column. This configuration may be referred to as an L-shaped structure. Current material handling systems exhibit anisotropic behaviour. That is, their two planar degrees of freedom require different amounts of force input from the operator. Movement of these devices is correspondingly difficult. One of the three most prevalent material handling devices, the jib crane, is selected for research into creating isotropic motion. Deflection occurs of T-section as a span of Jib crane which is mention in this project, to optimization of deflection to increase modulus of elasticity. Analysis showed that a T-section will withstand large transverse deflection without in-plane ply failure; the predominant failure mechanism is delaminating in the fillet region. Especially Jib Crane used for circular material handling, it menace radial work.

***Key words*:** Deflection, linear fibres, displacement, degree of freedom

I. INTRODUCTION

A crane is a mechanical lifting device equipped with a winder, wire ropes and sheaves that can be used both to lift and lower materials and to move them horizontally. Cranes are commonly employed in the transport industry for the loading and unloading of freight; in the construction industry for the movement of materials; and in the manufacturing industry for the assembling of heavy equipment. It serves a larger area of floor space within its own travelling restrictions than any other permanent type hoisting arrangement. Deflections of sandwich beams subject to concentrated or localized loads have been studied, and it is sufficient to accurately predict the vertical displacements in the face sheets of a sandwich beam. Flatness is an important process in the production of a T-section rail. In practice, the most common method for T-section flatness is the three points reverse bending based on handwork and the worker’s beneficial experience. Jib crane is a cantilever beam. In this paper, the load-deflection relations of T-section Under near loads is studied based on elastic-plastic theory. [1]

The linear hardening model and the elastic-plastic model are used for the analysis. It is know that the Jib cranes belong to the group of intermittent duty equipment. It is characteristic for them. Too, a tall and slender mast or tower, a long jib. A complicated load lifting, jib holding and luffing rope system, and, furthermore. That they commonly have four autonomous driving systems which can be started independently one by one, and two or three in stationary motions can exist at the same time. Displacement calculated method is studied considering the effect of self weight working ways and nonlinear deformation. A calculating formula of last point displacement of jib structures is deduced, in addition, large deformation finite element calculation method is used as criterion to evaluate the correctness and precision of formula in this paper. [1]

II. JIB CRANE WITH T-SECTION USING 270° SWIVEL

Jib cranes are widely used in industrial facilities all over the world. A typical jib crane consists of a top beam which is rotating around a fixed column. This configuration may be referred to as an L-shaped structure. The top beam is attached to the column at two points, directly on top and with down support. The trolley, with the hoist and payload, is moving along the top beam, Fig 2 (a).

Because the rotating speed of the top beam is usually very low and constant, the vibration components due to this motion are assumed negligible in this paper.

In such a case, the dynamic behaviour of the crane structure may be predicted with two dimensional models. In normal usage, the separation between the moving load and the loaded structure is prevented and it is reasonable to assume here that the moving trolley is always in contact with the crane structure. [3]

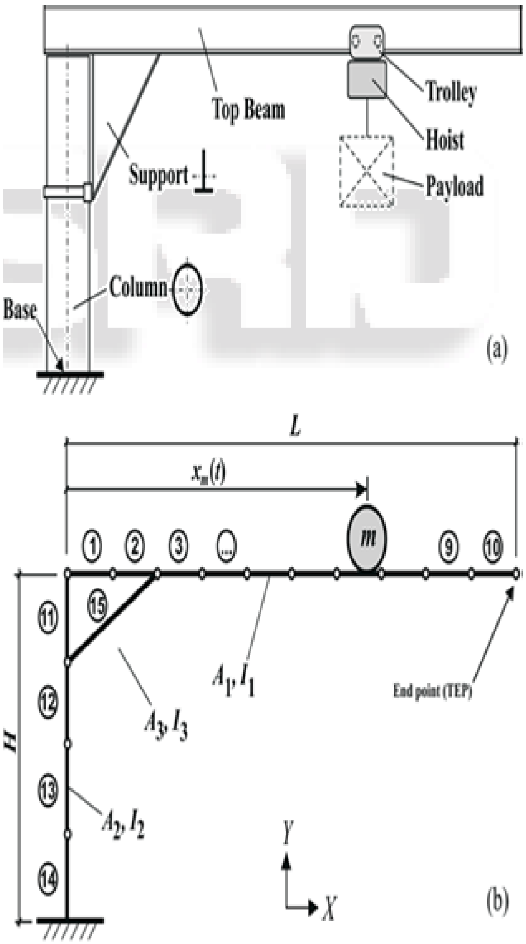

Fig. 2.1(a): Sketch for a column jib crane, (b) finite element model of a crane structure with moving mass

The moving trolley, hoist and payload are modelled as a moving lumped mass (m). It is assumed that the moving mass is travelling from the left end of the top beam with position defined by coordinate x_m (t).

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The finite element model of the jib crane structure i.e. framework, is shown in Fig 2(b). The top beam (with length) is composed of 10 identical frame elements with cross section, and sectional moment of inertia *I*1. The column (with height *H)* is composed of *10* identical frame elements with cross section *A1*, and sectional moment of inertia *I1*.

The column (with height *H*) is composed of 4 identical elements with properties *A2, I2* and the support is presented with one element with properties *A3, L3*. All the frame elements are made of steel with mass density ρ and Young's modulus E. [3]

Entrance into the durable goods manufacturing plant of today is marked by the dominance of overhead material handling systems. The purpose of these devices is simply to help workers move objects, weighing from 30 pounds to 100 tons, from one point to another. The overhead material handling systems discussed here have three degrees of freedom (DOF).

The two degrees of freedom in the horizontal plane are provided by motion of beams and trolleys, while the third, vertical degree of freedom is provided by a hoist. There exist three such types of systems.

The first 3-DOF material handling device and the one which is the subject of this thesis, is the jib crane.

An anatomical description begins with the mast. Mast which is secured to the floor, but other types of masts can be mounted to a wall or ceiling.

A rotational joint permits the boom (translucent in the figure) to rotate about the mast. While an axle and bushing type joint, joints with two or more hinges (like on a door) are common. There are two types of booms: enclosed track booms (shown in the figure) have a channel in which a trolley rides. [2]

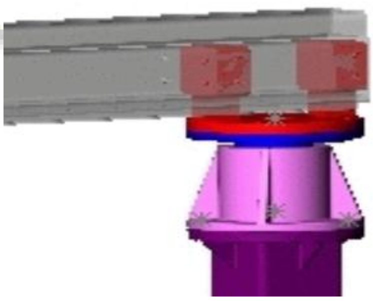

Fig. 2.2**:** Bushing Joint

This design keeps the rolling surface clean, significantly reducing rolling friction. The greater stiffness per unit mass of the T-beam boom provides increased capacity, greater span, and slightly lower inertia.

A hybrid boom combines the stiffness of the T-beam with the low friction of the enclosed track by stacking two such beams on top of one another. To finish up the description, a trolley translates along this boom. A cable or chain, often in conjunction with a hoist, suspends a load from the trolley.

Hoist and conveying machinery is at heart of modern in line production system and transfer lines. [2]

Carrying parts and products in a shop from one work station to another, transferring them from shop to shop or taking care of stockpiling and reclaiming operations, this machinery enables the process to go on without interruption and at a steady pace.

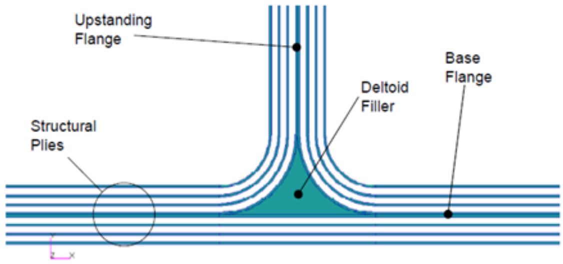

Fig. 2.3: T-Section Fibres

To meet higher production requirements, an automatic rail straightening machine is to be developed, and the load-deflection model of the bending process is suitable to be used on the straightening control.

The property sets for the T-section are generated in MSC. Patran Laminate Modeler according to Classical Laminated Plate Theory (CLT). In CLT, the stiffness matrix of the laminate is determined by the stiffness matrix of each layer (lamina) in the laminate and by the distance from the mid-plane of that layer. [2]

The lamina stiffness matrix is in turn determined by the effective ply properties in the warp and fill directions, and by the orientation of the layer with respect to a reference direction.

A balanced lay-up has a ply at a given orientation on each side of the laminate mid plane. In a symmetric lay-up, plies with the same angle are the same distance from the laminate centreline. A lay-up can be balanced and not be symmetric. Typical quasi isotropic lay-ups will use n = 3 (0°, 60°, 120°), or n = 4 (0°, ±45°, 90°), although any combination of angles that satisfy 180°/n could be used.

Depending on the material used, the in-plane effective tensile modulus of a quasi-isotropic laminate will be 6.5 to 11-msi, which is a large knock-down from the lamina modulus of 10.5 to 24-msi. In a stiffness limited application, it may be more effective to use aluminium than to use a quasi-isotropic lay-up. [2]

III. ANALYSIS APPROCH

Two sets of finite element models will be analyzed for each case to be evaluated. The first is a three dimensional combined shell element and solid element model that is used to evaluate overall part deflections and in-plane ply stresses. The second model is a cross-section plane strain model that will use deflection results of the three dimensional model as boundary conditions to deliver out-of-plane stress results. Stress results will be of greatest concern. Deflection results will be post-processed mainly to ensure that the T-section is behaving as expected under the boundary conditions. [4]

Stress will be evaluated for each layer (in-plane stress) and for inter laminar shear and tensile stress (out-of plane or through-thickness stress). Evaluating in-plane stress is a two step process. First, the maximum and minimum X, Y, and XY stress in each element is plotted. This gives a gross look at stresses in the part and points out any obvious failures, but does not show the stress field in any one ply – discontinuities will be apparent in locations that should not have them. The second step is plotting the X, Y, and XY

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stress in each ply individually. This will show the severity of hot spots and will allow the analyst to make an educated guess at the inter laminar stress field, based on stresses in adjacent plies in a given location. Potential locations of high inter laminar stress will be investigated using a cross-section model. [4]

IV. CONCLUSION

Through the literature review jib crane utilization where required radius type work. That is, their two planar degrees of freedom require different amounts of force input from the operator. Movement of these devices is correspondingly difficult. Fibres are elasticity Furthermore some additional load cases not contemplated in the norm have been established and they have a great interest for a correct design of the mechanical set, principally because the simulate some manoeuvres that, although they are dissuaded or prohibited, can happen during the use of the crane jib.

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