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Design and Analysis of Beam Lifting Mechanism for Textile Industries

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ABSTRACT: Solapur is well known for its textile business, where maximum numbers of textile industries are present. Because of these industries need of employment for Solapur people is fulfilled. The products manufactured in Solapur Textile Mills are cotton terry towels and bed sheets. These products are renowned in the country and have good market in India. Most of the industries are small scale industries with Jacquard looms. These looms require two warp beams for the production of towels and chaddars. After winding the threads on the beam, its weight becomes approximately 200 kg. In such industries these beams are handled manually, may be from one machine to another machine or for loading the beams on the machine.
This project deals with the design and analysis of textile beam lifting mechanism for small scale textile industries with rapier looms. The objective of the project is to design a safe and well performing beam lifter. The beam lifting mechanism uses pulley, drum and rope mechanism, these components are designed for extreme loading conditions. Frame structure is analyzed in ansys software and results are validated with analytical calculations.

KEYWORDS: Beam Lifter, Textiles, Handlooms, Lifting Mechanism.

I. INTRODUCTION

Beam lifter is general term for any equipment that can be used to lift loads. It is simpler and more robust device for material handling, by means of mechanisms like simple screw mechanism, hydraulic chain mechanism etc. This also includes jack, blocks and tackle, vacuum lifts, hoists, cranes and lifting pads.Solapur is the home of handloom and power loom industry. Once it had Asia's largest spinning mills. The development of the handloom weaving industry in Solapur commenced during the regime of the Peshwas. There are numerous small independent artisan weavers in the industry. The rise of the modern factory in India in the 1970s altered the organisation of the local hand-loom weaving industry.

This city has benefit of being on the border with Karnataka and Andhra Pradesh whichleads to access the major industrial towns in the country through the wide spread networkof railways. These factor in addition to the favourable climate has let to Solapurachieving prominent place on the industrial map of the country. Jacquard chaddars is theuniqueproduct manufactured in Solapur.

1.2 Introduction to looms

1.2.1 Jacquard loom

The Jacquard loom is a mechanical loom, invented by Joseph Marie Jacquard in1801,whichsimplifiestheprocessofmanufacturing textiles withcomplexpatternssuchasbrocade,damask and meatless. The loomis controlled by punched cards with punched holes, each row of which corresponds to one rowofthe design.

Fig.1.1 Jacquard Loom

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1.2.2 Rapier Looms

The rapier looms offer unparalleled versatility when it comes to yarns. From thefinest counts of cotton to the thickest industrial yarns and can handle anythingthrown at its negative rapier head. The soft-pick gear system enables smoothtransitionof even highlyfancyyarns like embroideryand slub.

Fig.1.2 Rapier Loom

1.2.3Warp-Weighted loom

Thewarp-weightedloomisaverticalloomthatmayhaveoriginatedintheNeolithicperiod.Theearliestevidenceofwarp-weightedloomscomesfromsitesbelongingtothe StarcevocultureinmodernSerbiaandHungaryandfromlateNeolithicsitesinSwitzerland.ThisloomwasusedinAncientGreece,andspreadnorthandwestthroughoutEuropethereafter.Itsdefiningcharacteristicishangingweights(loomweights)which keep bundles ofthe warpthreads taut.

1.3 Problem Statement

As textile industry is a large source of employment, there are certain areas in which improvements can be made. Oneoftheseisbeamliftingwhichispresentlydonemanually.Thesame canbedonewith a certain devicesuitablefortheir conditions.So we visited to a textile industry in Solapur named as 'Yanganti Textiles' andtaken a closer look over the industry.Here threads are wounded on beams using warpingmachine. Initially weight of empty beam is Approximately 20 kg, but after wounding thethreads the weight of beam increases up to 200 kg. Then this beam has to be carried fromwarp machine to the loom. In most of textile industries these beam are carried manuallywhich needs 4 to 6 workers to carry and lift. During gang lifting 200 kg beam, there isalways probability to happen any accident which can cause serious injuries like bone fracture. To address the above mentioned issues design and analysis of beam lifting mechanismis chosenas academicproject.

Fig.1.3.1 Actual Beam

Fig.1.3.2 Beam Mounted on Loom

1.2 Literature Survey

[1]Warping is an essential process for manufacturing woven fabrics. There are two systems mainly used for the same viz. Direct and Indirect. In the paper an attempt has been made to review some design modifications patented already. Also, it contains limitations of the designs attempted so far. Out of two systems of warping, users have their own application area for selecting a particular system. Merits and demerits of both systems are discussed in the paper.

[2] This paper is concerned with the concept of composite ropes for lifting applications. The level of wire rope technology used in lifting or hoisting applications has a significant effect on the overall efficiency of the system. This paper presents various examples which show the different benefits which may be accrued from the use of lightweight ropes. The analysis in this paper has shown that lightweight ropes have considerable potential in hoisting applications.

[3]The scope of the research is to study Design and Selection of material for lifting different types of load. The main aim of this paper is to develop different types of Beam Lifters. The focus is on the design of heavy beam lifters with different loads.

[4] The inevitable contribution of wire rope in service is discussedwith an overview of the consequences in terms of inspection and replacement criteria.Details are presented of specific degradation mechanisms observed in three differentapplications: a mine hoist rope operating

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on a drum winder, a mooring rope for anoffshore structure and a spin-resistant single-fall offshore crane rope. In each case themechanisms are analyzed and steps outlined to alleviate the problems. It is concluded thatgeneralizationisinappropriate:maintenance,inspectionanddiscardpolicymustbedetermined in recognition of the degradation mechanisms that operate in different ropeapplications.

[5] The scope of the research is to study a methodology toreduce the weight and the cost related to big frame steel structures during the early designphase, which is the phase where most of the project layout is defined. The main aim ofthispaperisthedevelopmentofaplatform-tooltosupporttheautomaticoptimizationofasteelstructureusingvirtualprototypingtoolsandgeneticalgorithms.Thefocusisonthe design of heavy steel structures for oil & gas power plants. This work describes indetail the design methodology and estimates the weight saving related to the re-designprocess of a test case structure. The designcases considered in the paper are thoserelevantto the operating.

[6] This paper deals with the problem of dynamic behaviour of load lifting mechanism (such as elevators). In the case of considerable lifting heights, high velocity devices are applied, with the purpose of shortening cycle duration and increasing the capacity. In such case, the standard procedure of dynamic analysis is not applicable. In the paper, the procedure of establishing the appropriate dynamic model and corresponding equations is proposed. It enables the analysis of the relevant influences, such as variation of the rope free length, slipping of the elastic rope over the drum or pulley and damping due to the rope internal friction.

[7] There are many factors affecting the resistance loss of wire rope pulley, such as tension of wire rope, diameter of pulley, envelop angle and so on. In this paper, based on the mechanical model of wire rope over pulley, the bending effect of wire rope is considered. And the non-linear equations of exit tension with entry tension, pulley radius are constructed. There is no another product that can replace the wire rope as most popular carrying.

[8]This work deals with Lifting beams design and analysis. This is important to minimize unwanted erection stresses or to prevent reversal of stress in certain portions of the lifted object. So the design of lifting beams plays a crucial role in the wellness of the lifted object. A lifting beam is a solid or fabricated metal beam, suspended from a hoist/crane or from forks of a forklift, designed to provide multiple lifting points. The lifting beam enables the user to attach the load at more than one point therein securing and controlling the load's movement. Lifting beams are designed to be loaded in bending. A simple lifting beam will have an eye or link on the top side to connect to the lifting machine hook and two or more lifting points on the underside to connect to the load.

[9] This work deals with the problems faced by the labors in textile industries and the methodology to reduce it, resulting in more productivity in the labors. In this study it was found that the occupational health and safety awareness among the textile workers is very low and there needs to provide proper trainings to the workers.

1.4 DESIGN OF BEAM LIFTING MECHANISM

The prototype of actual lifter is developed in Solidworks. This model is developedaccording to the dimensions of the loom where it can be easily mounted. The design partincludes the analytical as well as the analysis part. The lifter is designed considering thebending stresses developed in the members.

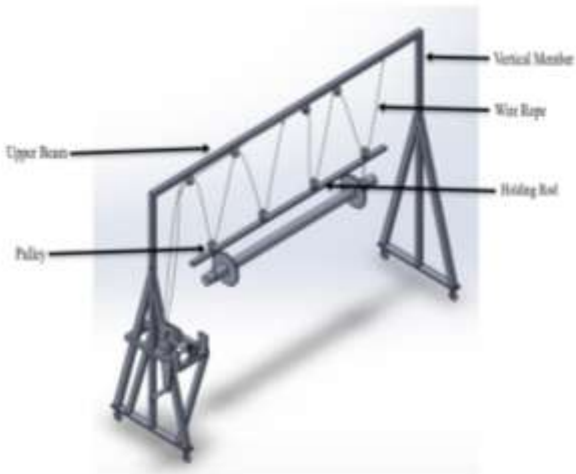

Fig.1.3 Design of Beam Lifting Mechanism

As the fig shows the beam lifting mechanism, the design consists of Holding rod on which the beam is holded which is acted by four upward forces and two downward forces. And the Upper Beam which is acted by six downward forces.Theverticalmembertakes theloadofholdingrod, upperbeamandweight of beam. The beam is designed as per the textile layout. The material used for the mechanism is Mild Steel. Below table shows the properties of the material.

Material	Mildsteel(Fe250)
Yieldstrength	250 N/mm^2
Ultimatetensilestrength	410 N/mm^2
Density	7850Kg/m^3
Young'smodulus	210G Pa
Poisson'sratio	0.29

1.5 ANALYSIS OF BEAM LIFTING MECHANISM

1.5.1 UPPER BEAM

The Upper beam is acted upon by six downward forces. Below figure shows the stresses in the upper beam.

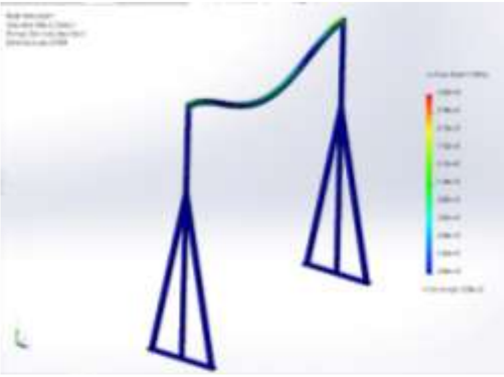

Fig.1.5.1 Stresses in Upper Beam

Fromthe fig themaximumvalueof stressobserved inthe upperbeamis

σ_{ans}=102.2N/mm^2

Analytically,

$Z = \frac{a^4-b^4}{6a}$

$= \frac{49^4-40^4}{6 X 49} = 10900\ mm^3$

$\sigma_b = \frac{M_{max}}{Z}$

$= \frac{1117620}{10900}$

σ_b=102.5N/mm^2

Here,σ_{max}=σ_b

TheanalyticalvalueandAnsysvaluesarealmostsame, hencethedesignissafe.

1.5.2 Holding Rod

The Holding Rod is acted upon by four upward forces. Below figure shows the stresses in the Holding Rod.

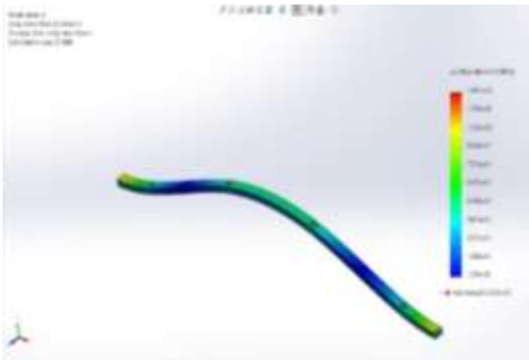

Fig.1.5.2 Stresses in Holding Road

Fromthe fig themaximumvalueof stressobserved inthe Holding Rodis

σ_{max}=128.7N/mm^2

$Z = \frac{a^4-b^4}{6a}$

$= \frac{30^4-22^4}{6 X 30}$

$Z = 3198\ mm^3$

$\sigma_b = \frac{M_{max}}{Z}$

$= \frac{330000}{3198}$

σ_b=103.18N/mm^2

Here,$\sigma_{max}\approx\sigma_b$

TheanalyticalvalueandAnsysvaluesareagreeing,hencethedesignissafe.

1.6 CONCLUSION AND FUTURE SCOPE

1 The Design of the Beam Lifting Mechanism will be able to carry the beam load.
2 Analysis was carried out of the designed parameters of beam lifting mechanism,
3 Beam lifting mechanism with a low cost than other commercial beam lifters will be available.

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