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Ergonomic design of creel used for warping of beams in textiles

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ABSTRACT

Ergonomics plays a vital role in productivity as it is directly concerned with the fatigue of the workers. Creel in textiles is a structure on which bobbins or reels are mounted. The number of bobbins is ranging from 400 to 1200. These are to be loaded manually. For this, a person has to sit & stand many times. Due to this, fatigue occurs. Absenteeism of workers also increases due to this fatigue. In this research work, modifications in the creel are suggested. The creel is now split into two parts. Upper part remaining fixed & lower part kept movable/ rotatable. Because of this arrangement, lower part can be taken on upper side & all the bobbins can be loaded in standing posture only. Hence fatigue is reduced a lot.

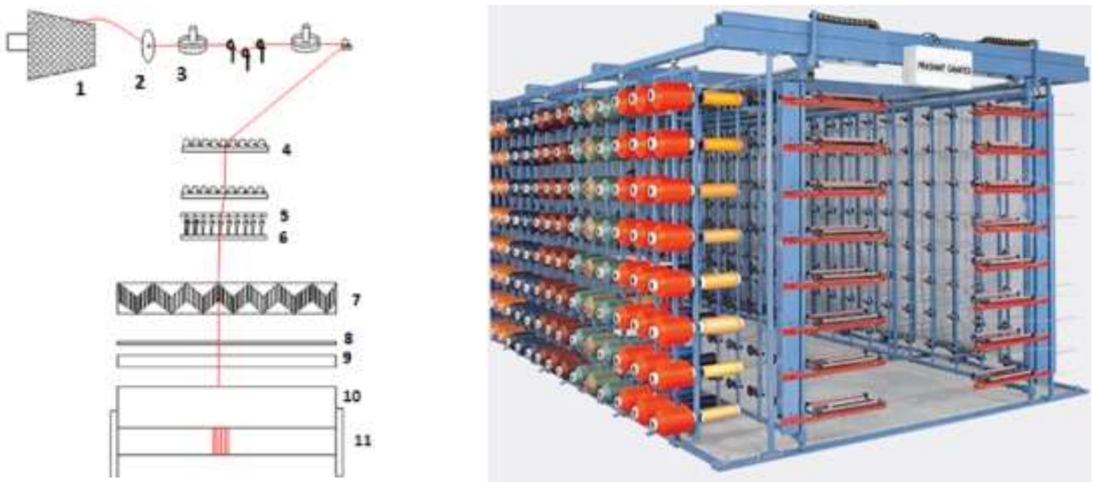
Keywords: *Creel, ergonomic design, bobbin, fatigue*

1. INTRODUCTION TO ERGONOMICS

"Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance".

Ergonomics is an important aspect in an industry. The ergonomic factors play an important role in the effective running of a company, so these factors are to be considered seriously. In the ergonomic study, various aspects of the industry are to be considered that relates to the employees; while working. The ergonomic problems will affect the workers in a negative way; this will lead to decrease in productivity, non-achievement of the target.

Usually, ergonomics evaluations are performed by ergonomists, while workplace layouts are designed by planning engineers, and the results are often unsatisfactory and do not improve productivity. So a study of ergonomic factors or facilities affecting workers in an industry is important. In an industry, ergonomics play a key role if proper ergonomic facilities are not provided it will affect the performance of the company. [1]



1. Bobbins or reels, 2. Baloon Breaker, 3. Yarn tensioner, 4. Yarn guide 5. Ceramic guide, 6. Auto stopper, 7. V-reed, 8. Lease rod, 9. Roller, 10. Pressure roller, 11. Pre-beam

Fig. 1: Warping process & creel

2. WARPING PROCESS & CREELS IN TEXTILES

Warping process: The parallel winding of warp ends from many winding packages (cone or bobbins) on to a common package (warp beam) is called warping. Direct Warping denotes the transference of yarns from single-end yarn packages, wound packages, directly to a beam in a one-step process.

Creels: Independently of the warping system, the threads are fed from bobbins placed on creels. The creels are simply metallic frames on which the feeding bobbins are fitted; they are equipped with yarn tensioning devices, which in modern machines are provided with automatic control and centralized tension variation. Figure 1 shows a picture of creel used to hold the yarn cones or bobbins.

Moreover, the creels are equipped with yarn breakage monitoring systems. The creel capacity is the parameter on which the number of warping sections or beams depends; it should be as high as the installation type and planning permit; the usual creel capacity amounts today to 400-1200 bobbins. Various solutions have been designed to reduce the time required to load the creel and thus increase the warping performance.

3. PROBLEM IDENTIFICATION

Lots of movements are involved in the process of loading of bobbins on a creel. The person doing the loading work has to sit down & stand up many times during the work. For much time the workers have to bend while working. The fatigue of the worker's increases due to above nature of work. This further leads to absenteeism of workers.

4. OBJECTIVES OF THE WORK

Following are the objectives of the dissertation work

- To study the existing design of creel
- To collect the data related to bobbin loading
- To study human involvement in the above process
- To redesign creel to reduce fatigue of the workers

5. OBSERVATIONS DURING ACTUAL VISIT

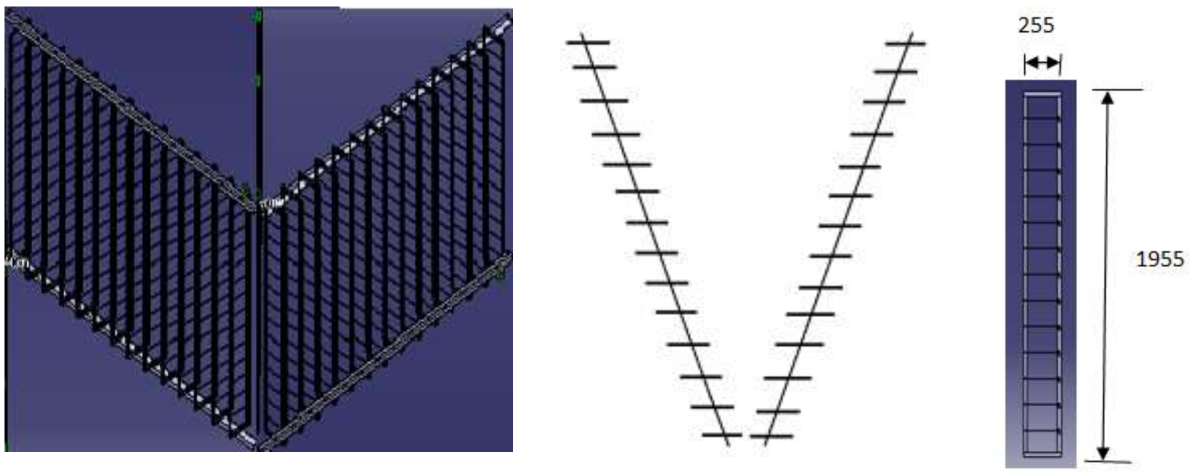
- Creels used in Solapur based textile industries are of a V-shaped frame having a rigid structure as shown in figure 1.
- Number of thread rolls (bobbins) to be loaded on creel is about 400 at a time.
- About 14 columns & 15 rows are there on which bobbins are to be loaded.
- As per the demand, one creel may be loaded 2 or 3 times in 8 hours working shift.
- The bobbins are located at different levels from the ground & a person has to move down & up many times during the bobbin loading process.
- During the warping process, one end of the thread from each bobbin located at different positions is to be taken on the warp beam.
- After completion of warping process, empty bobbins are to be removed from the creel.

Thus overall lots of ergonomic problems are existing during the bobbin loading operation on the creels. Thus creel design needs an improvement.

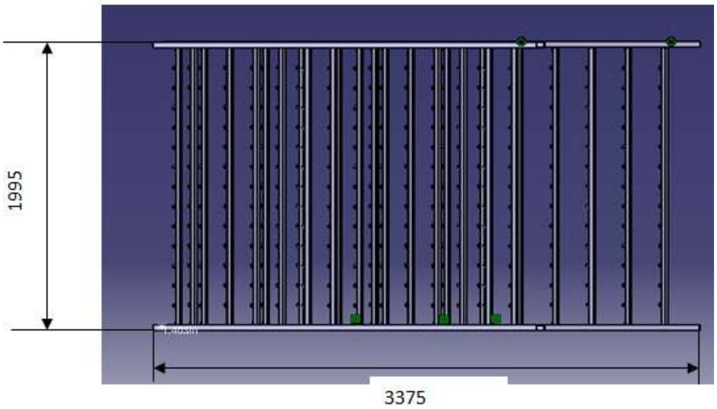
6. DESIGN OF ERGONOMIC CREEL

6.1 Details of Existing creel

Total No. of frames on one side of creel = 14
Frame size = 1995 mm x 255 mm
The frame is made of an angle of 25 mm x 25 mm x 3 mm
Weight per meter of angle = 1.1 kg [4]
No. of reels /bobbins mounted on one frame = 13



(a) Model of existing creel **(b) Top View** **(c) Angle frame**



(d) Side view

Fig. 2: Existing creel structure

6.2 Proposed design of creel

It is proposed to split the above frame into two parts. The upper part will remain fixed. The lower part will be made movable. It can be taken on the upper side near /adjacent to the fixed frame.

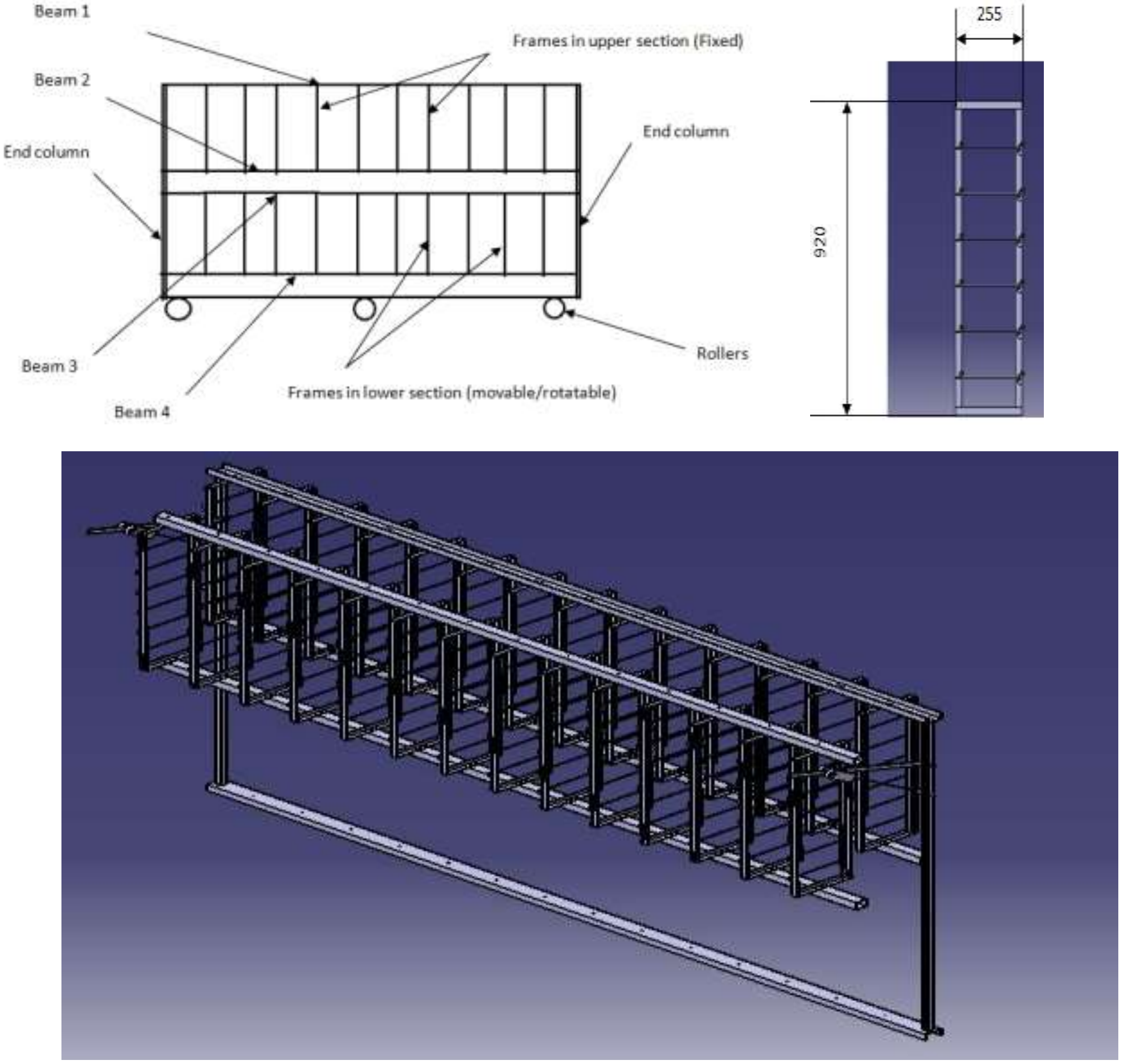


Fig. 3: Proposed creel structure and new frames

6.3 Design of beams for supporting upper frame:

Instead of single large (vertical side) frame, now two frames will be there. The upper frame which is being kept fixed. The lower one is kept movable/rotatable.

Frame: The height of the upper and lower frames will get reduced to slightly less than half of the height of the existing frame.
Let the height of the new upper frame will be 920 mm.
Total length of frame = (920+255) x 2 = 2350 mm

Mass of frame = 2.35 x 1.1 = 2.585 kg
No. of reels /bobbins mounted on the upper frame will be reduced now. The number of reels will be slightly less than the half of the number of reels /bobbins mounted on the existing frame.
Let 6 reels/bobbins be on one upper frame.
Mass of one filled bobbin/reel = 250 gm
Total mass of all the filled bobbins/reels = 0.25 x 6 =1.5 kg
Total mass of frame including filled reels/bobbins = 2.585 +1.5 = 4.085 kg
As the value 4.085 kg is point load, this load acts at 14 points and the length of the beam is very large (=3.375 m), the deflection of the beam will be more.
Hence, taking the material of the frame as aluminum,
Density of aluminum = 2700 kg/m^3
Density of mild steel = 7850 kg/m^3
Mass of aluminum frame = 2.585 x 2700/7850 = 0.89 kg
Mass of aluminum frame including bobbins/reels = 0.89 +1.5 = 2.39 kg
Thus it is observed that mass of frames is reduced from 4.085 kg to 2.39 kg. Thus 41.49% reduction in mass has occurred.
Weight of single frame including reels/bobbins = 2.39 x 9.81 =23.45 N
Total load on the beam = 14 x 23.45 = 328.3 N

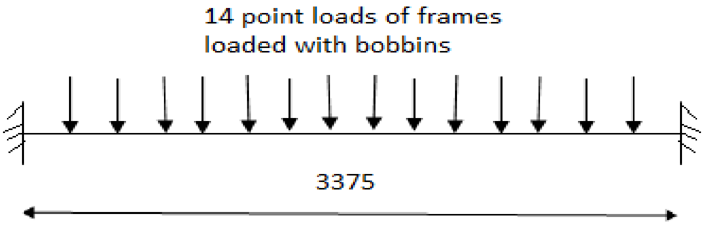


Fig. 4: Beam for supporting frames

Due to non-availability of formula for a beam with fixed ends and a large number of point loads, the load is taken as a uniformly distributed load.
Let the deflection allowed at the center be 1 mm.

$\delta = \frac{wl^4}{384\,EI}$ ……………… here 'w' is load per unit length

The above equation can be written as

$\delta = \frac{Wl^3}{384\,EI}$ ………… Where 'W' is total load.

Hence,

$\delta = \frac{328.3\ x\ 3375^3}{384\ x\ 2.08\ x\ 10^5 x\ I} = 1$

I = 1,58,015 mm^4

Moment of Inertia of square tube with 50 mm side & 3 mm thick is

$I = \frac{a^4 - b^4}{12}$ ……….. here, a = length of outhe ter side of square tube &
b = length of the inner side of square tube

$I = \frac{50^4 - 44^4}{12}$ = 2,08,492 mm^4

As the load will be actually shared by the two beams support members 1 & 2, above the tube, is finalized.

6.4 End Columns to support the frames:

The two tubes at the ends will be the members taking the total load axially. These will be of mild steel.

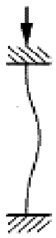


Fig. 5: End columns taking a complete load of upper frames and lower frames

Total load = 328.3 x 2 = 656.6 N
Load on each tube = 328.3 N
Let us check the tube which is acting as a column for Euler's buckling load.

Euler's buckling load for a column with both ends fixed = P = $\frac{n\ x\ \pi^2 x\ E\ x\ I}{L^2}$….for L/r >120 (steels)

Here, r = radius of gyration of column

For square tube, r = $\frac{\sqrt{a^2+b^2}}{12}$

Let us check the suitability of a square tube of 25 mm x 25 mm with a thickness of 0.5 mm.
Hence a = 25 mm & b = 24 mm

Hence, r = $\frac{\sqrt{25^2+24^2}}{12}$ = 10

Length of column (square tube) = 1995 mm
L/r = 1995/10 = 195.5
As 195.5 > 120 … above formula can be utilized to check Euler's buckling load.

Euler buckling load = P = $\frac{4 \times \pi^2 \times 2.08 \times 10^5 \times 4904}{1995^2}$ = 10117.83 N

Here n = 4 …….for both ends fixed columns &
For I = 4904 …….for a square tube with 25 mm outer side & 0.5 mm thickness.

The above thickness is chosen to take into consideration the welding of the component. The columns of still smaller thickness will not sustain the temperature during melting and welding will not be proper.
As above value of Euler buckling load is much higher than the existing load (328.3 N), the column is safer.

6.5 Design of support hinge pin for lower frame:
Total pins = 2 …(One at each end)
Total load on the pins is 328.3 N
Load on single pin = 164.65 N

Considering shear failure,
Shear strength of mild steel, f_s = 200 x 0.5 = 100 MPa
The pin will be in double shear.
Considering factor of safety = 4
Allowable shear stress = 100/4 = 25 MPa

Shear stress = $\frac{Force}{Area}$ = $\frac{164.15}{2 \times \frac{\pi}{4} \times d^2}$ = 25

d = 2.04 mm
As the above value is very less, let us take 10 mm pin for safer consideration.

7. CONCLUSIONS

In this research work, the design of creel is done to reduce the fatigue of the workers.

- Due to the newly designed creel, loading & unloading of all the bobbins (on upper side & lower side both) can be done in standing posture. Hence elimination of bending of the person every time for loading & unloading of the bobbins on the lower side has occurred. This has reduced the fatigue by nearly 30%.
- Also, fatigue due to the process of taking the thread from bobbin & passing it through mesh has been eliminated as the above process also can be done in standing posture.
- The time required to load & unload the bobbins & take the threads from bobbins to the mesh has been reduced by nearly 30%.
- As the new creel is having frames of bobbin loading of aluminum material, the overall weight of the creel is reduced by about 30%. This reduces the efforts required to move the creel to the desired place.
- Cost of the new creel is nearly same as the existing creel.

8. REFERENCES

[1] Arun Narayanan, Cijo Mathew, Vinod Yeldo Baby, "Improvement of Ergonomic Factors That Affects Employees in a Textile Industry", International Journal of Engineering Science and Innovative Technology (IJESIT), Volume 2, Issue 1, January 2013.
[2] Dr. R. K. Bansal, A Textbook of Strength of Materials, Laxmi Publications (P) Ltd., New Delhi, 2014.
[3] R. S. Khurmi & J. K. Gupta, A Textbook of Machine Design, Eurasia Publishing House (Pvt.) Ltd., New Delhi, 2015.
[4] Design Data- Data Book of Engineers, PSG College of Technology, Kalaikathir Achchagam, 2008.
[5] A. D. Dubey, "Role of Ergonomics to Improve Productivity in Textile Industries", International Journal of Engineering Research & Technology (IJERT), Vol. 3 Issue 2, February – 2014.
[6] D. C. Metgud, Subhash Khatri, M. G. Mokashi, P. N. Saha, "An ergonomic study of women workers in a woolen textile factory for identification of health-related problems", International Journal of Occupational & Environmental Medicine, Vol. 12, Issue 1, April 2008.
[7] Maria Luiza Caires Comper, Rosimeire Simprini Padula, "Ergonomic risk assessment among textile industry workers using two instruments: Quick Exposure Check and Job Factors Questionnaire", Research Gate, Jan. 2017.

