

ORIGINAL ARTICLE

Design and Fabrication of Rotary Carpet Washer

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ABSTRACT

Various shapes and qualities of the Persian carpets have traditionally been the part and parcel of the Rural Iranian cottage industry and urban comfort. Its economic and cultural value cannot be underestimated. For this reason, their maintenance and washing practices and provisions play a crucial role in protecting their physique which culminate in elongating their lives. The aim of this paper is to design a mechanized rotary carpet washing machine to function in such a way to wash the carpets while protecting them against the potential destructive stresses. The design features include lower water consumption and drying time. The methodology involves initially designing the necessary mechanical components that can perform on carpets with a 6 square meters dimensions. Appropriate mechanical, electrical and electronic appurtenances were mounted on the system to perform effectively in conjunction with a dryer unit to finish the washing processes. The system was finally tested for operational quality and reliability and the outcome was a satisfactory operational efficiency and effectiveness.

Keywords: Carpet-washing, dryer unit, rotary, electromotor

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INTRODUCTION

Problems of IEQ (indoor environmental quality) which are related to keeping and washing carpet should be taken into account generally. At the present time, apparent applications of washing carpet are unrelated. Commercial's issues are related to keeping of organic buildings are unrelated to each other and seldom daily cleaning of the house, periodical keeping and cleaning problems are related to each other. Suitable keeping and cleaning efficiently are done at a situation in which necessary investigations for doing are done, a proper management is efficient of this way and so we can impede some problems. Issues related to IEQ [1] the major part of the science, today entitled "science of washing carpet" apparently is related to minor or limited problems, and have nothing to do with cleaning process. Although, a widespread and numerical studies about the amount of dust in the carpet is done, these ways are deficient, since they couldn't provide the situation in which the cleaning qualification be done as a normal way [2]. In washing a carpet, different ways and steps should be considered, like preliminary of washing, removing dust from the carpet, surveying is done to recognize faults and remove blurs. Then with the help of mechanical devices in the factory or by the traditional ways in the house, the carpet is washed [3]. In washing the carpet, different traditional or industrial materials, are used which having knowledge about the effect of each material will increase the better efficiency of our work. In during of washing and after that, different supplemental operations are done on the carpet as, chlorine or washig with {carbohydrate, sood, and carbonate anticloth} carpet which each one issued to provide a special goal or convenience for consumers, knowing about these chemical materials on yarn of carpet will be useful in the better applying of them for appropriate washing [4].

MATERIALS AND METHODS

A brief overview and expression of rotate washing of carpet's operation.

The width edge of carpet is located on the cylinder, and is shrieked with a full rotate of cylinder. Then, water and blubber from separate inputs are poured on the carpet and regarding to cylinder' operation, all points of carpet touch the water and blubber. After that the carpet is washed by a rotating brush which is located parallel to cylinder. Then, the centrifugal force generated by high revolution and blowing hot air drying is done. The general structure of the set confirms to the following figure (1).

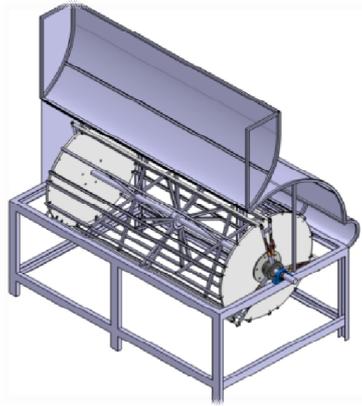


Figure (1).the general structure of rotate washing carpet device.

The base is made of two parts: the lower part which is responsible for tolerating the force of component of the system, such as; cylinder, Cover, carpet and etc, and the upper part which keeps components and prevents the hot air from voiding, when the drying operation is done and is considered as the boundary between system and environment. The weight and geometry of the device should be as the whole system and be in a balanced mode. Also there is no vibration from the torque shaft. As the shaft rotates, rotating cylinder rotates. Rotating cylinder is made of different parts. These parts are as follows:

2-meter rods screwed to diametric rod of shaft, two circular plates with thickness 20mm and 510mm which are linked to end of axial rods of cylinder and a solid piece which firms the plates on the shaft. Also clamp mechanism is used on rotating cylinder. For tolerating radial, axial and combined loads, bearing are mounted on the base and the shaft rotates in it. The clamps mechanism involves linear tubes which prevent carpet from moving and slipping. Retaining tubes are screwed on the head of slipping pin. Then with moving of lever, we can locate the mechanism in a locked or released mode.

Design and calculate intermediate shaft of the rotating cylinder

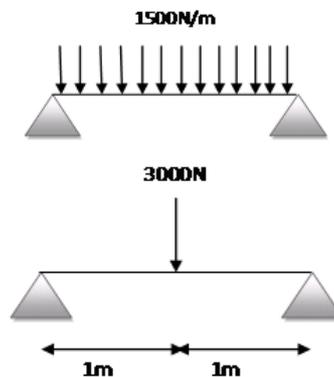
The purposed shaft is made of steel that yield stress is 310 mPa, with Reverse bending moment capacities, factor safety is 2 and is designed with maximum shear stress and von mises criterion.

Widespread load resulting from mass pieces of rotating cylinder which is 200kg and mass of wet carpet which 100kg is considered.

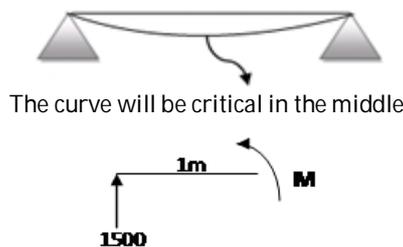
$$W = m \cdot g = (100 + 200) \times 10 = 3000N$$

This weight is imposed on a 2m shaft.

$$q = 3000 \div 2 = 1500N/m$$



Convert the widespread load to concentrated load to could gain critical momentum.



The shaft is cut from the middle and then momentum is calculated:
 $M = 1500 \times 1 = 1500N.m$

For revolution of shaft in 300 rpm, we use a electromotor with power of 15 hp.
 $P = 15 \times 746 = 11190 \text{ wat}$

And also we have,

$$)1 \quad (P = T \times \omega)$$

$$\omega = 300 \times \frac{2\pi}{60} = 10\pi \text{ rad/s}$$

So torque is

$$11190 = T \times 10\pi \rightarrow T = 356 \text{ N.m}$$

So according to cutting tension criteria

$$D = \left[\frac{32n}{\pi S_y} \sqrt{M^2 + T^2} \right]^{(1/3)} \quad (2)$$

$$D = \left[\frac{32 \times 2}{\pi \times 310 \times 10^6} \sqrt{1500^2 + 356^2} \right]^{(1/3)} = 4.7 \text{ cm}$$

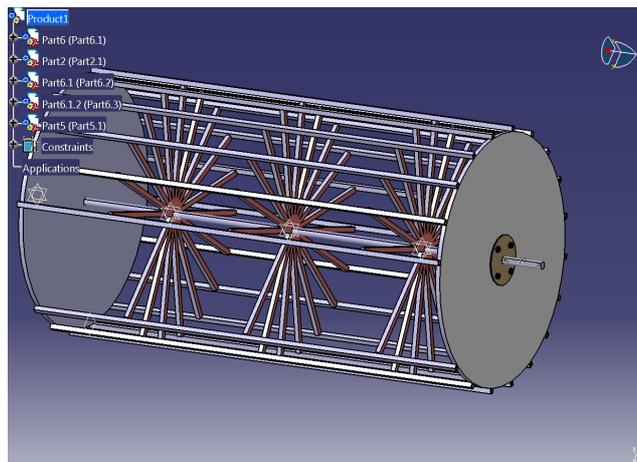
and based on von mises criterion

$$D = \left[\frac{32 \times 2}{\pi \times 310 \times 10^6} \sqrt{1500^2 + 0.75 \times 356^2} \right]^{(1/3)} = 4.6 \text{ cm}$$

So the purposed shaft with outer diameter of 4/6 to 4/7cm is apt. however, for making it, a 50mm diameter is considered.

Modeling components of device

The modeling of main chassis and rotating cylindre, shaft, the end cover and bearings are done by Catiasoftware. The rotating cylindre's model has been shown in the fig(2).



Fig(2). Rotating cylindre modeled

ASSEMBLE OF COMPONENTS

After designing, modeling and building components, these are Assembled. Constitutive components could be divided into 5 basic categories;

- Mechanical components
- Electrical components
- Electronical components
- The unit of providing required water for washing
- Dryer set consisting of heaters and blower

Mechanical components

The components are consist of main chassis of device, rotating cylindre, slipping plates (frames), bearings, rotating rods and rotating brush.

Considering the size and gender, each component is designed, made and assembled. One of the limitations of this part is related to central rotating rod that according to its length and weight is severely affected by bending and ecentric mode, especially at the time of relocation. Ofcourse it has a negative effect on balance, especially at the time of revolution, and also will create a very severe vibration in high vibration that could take disalignement of electromotor.

Electrical components

For starting rotating cylinder, an electromotor with 7.5hp and 1440rpm and for starting brush, an electromotor with 0.5hp and 1390 rpm is used. It should be mentioned that the speed of electromotor is adjustable and rotates in 50,20,150,100 and 250rpm. Related electromotor also rotates in 20 rpm that its responsibility is to engage the carpet for washing.

Electronics components

Electronics board is the only piece which is used to adjust different rotation, that is related to rotating cylinder. It has been shown in fig(3). (it's known as a driver.)



Fig(3). Electronics board for adjusting different revolutions of electromotor.

The unit of providing required water

For wetting the carpet, a pump with 40-20 model, is used which is made in Iran pumping company(Fig4). The required water is pumped and is conveyed by a steel tube which is located at the top of rotating cylinder. 10 nozzles are injected to speed up the water, when is pouring on the carpet (fig5).

Dryer unit

This unit consists of heaters and blowers which of course after finishing abating step it is located under the device and drying operation is done after abating. It could mechanismly leads under the device which of course by considering financial limitations of this design, this work is done manually (Fig6).



Fig4.the used pump for pumping water



Fig5.Set of nozzles

Testing

For doing the test, a 6m carpet with 2*3m size is located on the rotating cylinder. Use special clamps which were made in advance to hold the carpet on the rotating cylinder.



Fig.6.Set of used dryer unit

Then, rotating cylinder will rotate at 20rpm, at this time for wetting the carpet, the providing unit of water, will spray the required water on the carpets surface by the nozzles monotonily wet the carpet surface. One of the main goals of this design is to reduce consuming water, that of course by considereing to that the water with high speed and by nozzles is injected on the carpet, in comparision with usual ways which are done by sinking in the water and a lot of sprayed water is voided and is frivol and its result is the reduction of consuming water. 5 minutes is the required time. After this step, washing powder or chapeau is sprayed on the carpet, of course this step could be done mechanimly (like spraying blubber on the automobiles, when you are washing the car) but because of limitations of design and the cost for providing required pump, this step is done manually. In this step, rotating brush challenged with carpet, and washing is started. One of the advantages of this design, is that washing operation is done in carpets depth, because the carpet is all around the rotating cylinder, so the carpet's warp and woof are away from each other. This matter cause better cleaning of carpet. It's sssential to say that in during of wetting step and washing carpet, rotating cylinder rotates at 20rpm. 15 minutes is the required time which is considered.

Then, with adjusting the round of electromotor, extend it at 150rpm and draining step is done.

In this step, with increasing the speed of carpet' revolution and with referring to centrifugal force, the carpet's water is caught and seprated gradually the rotating cylinder' speed increased to 20rpm and 250rpm, so draining operation is done completely. 10 minutes is the required time which is considered.

After that, with the use of dryer unit, drying operation of carpet is done completely. Hereby, with the use of blowers and electrics heaters, the lower part of the device, hot winds at high speed hit the carpet, at during of this step rotating cylinder rotates at 20rpm. 30 minutes is the required time which is considered. The general purpose of this design is to reduce consuming water, power, the washing and drying time. So, washing and drying operation for three 6m carpet is done for three times. The average of consuming water, power, and the spent time for washing and drying is 25lit/m, /4kwh and 4/5 hours respectively, according to inaccessibility of exact information about the rate of consuming and power.

Usual methods of washing carpet are used to by referring to washing carpet's centers access average information of these statics. So in several centers, the whole washed carpet in one month at square meter of carpet is considered and according to related water bill, the rate of consuming water in each square meter measure.

Also about the consuming power in each square meter, kwh of measured consuming water that average of these statics are matched with the table of 1.

Table (1). The gained information of washing carpet's center

Time drying)hour(Time washing)hour(Consumed electricity)m ² /kwh(Consumed water)m ² /lit(centers
24	1	0.4	50	Carpet wash1
48	0.5	0.3	40	Carpet wash2
24	1.5	0.5	30	Carpet wash3
32	1	0.4	40	average
4	0.5	0.4	25	rotary carpet washing machine

CONCLUSION

According to gained data, it's clear that the rate of consuming water, consuming power, a the duration of washing and drying, as it was predicted, for washing with this device, in comparison with usual ways is lower. With three times repetition for three carpets of 6m, the rate of consuming water in each square meter is about 25 liter that in proportion with the rate of consumed water for each square meter in comparison with other ways has reduced. Also the rate of consuming water, the spent time for washing and drying operation, considerably is reduced. On the other

hand, by referring to overall cost for making this device, comparing its foreign samples, with completely different mechanism, is more economical. In foreign samples, washing is done naturally.

REFERENCES

1. Air Quality Sciences, Inc., Carpet Cleaning and Acceptable Indoor Air Quality: A General Review of Carpet Cleaning Effectiveness, June 1999.
2. Bishop, L. J. More Answers than You Have Questions about Carpet Cleaning, Vols. 1 & 2. Clean Care Seminars, Inc., Dothan, AL, 1991 (rev. 1997).
3. Carpet and Rug Institute (CRI), "Cost Comparison of Carpet versus Vinyl Floor Coverings," Carpet and Rug Institute, Dalton, GA, 2001.
4. Cole, Eugene, DrPH, et al. Indoor Air Quality Monitoring in Carpeted Environments. March 1992.

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