Design, Development and Fabrication of Stirrup Making Machine Energized by Human Powered Flywheel Motor

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***Abstract*- In this research paper preset the stirrup making process by using human power flywheel motor. This set-up is used to bend the round bar. Stirrup is one of the essential element of reinforce cement concrete in civil construction. These stirrups are used for strengthening columns and beams, avoiding buckling of long slender column and avoiding sagging of horizontal beam. Traditionally stirrup are made on a wooden platform providing with pins and the rod is bent with the help of lever. The force is applied on lever and the pin works as fulcrum point for bending the rod.**

This present manually stirrup making activity indicates that the process suffers from various draw back like lack of accuracy and due to repetitive motion of his hands subject internal injury to his body organ like carpel tunnel syndrome, spondylitis, muskulo-skeletal disorder, etc.

Keeping these things in mind, we have designed and developed a machine which will used for stirrup making (i.e., Human power).

Keywords*— *Human Power, Flywheel Motor, stirrup, Traditional Method, Column

I. INTRODUCTION

In the present age of use of electricity, petrol,diesel, fossil fuels etc. For production. In the age of the human power was neglected but hazardous environmental pollution caused by fossil fuels again brought the human power in the mainstream of renewable power resources. So in recent past vast research is going on for harnessing human power. A stationery system similar to a bicycle having flywheel is conceptualized as Human Powered Flywheel Motor (HPFM) [1-4] in which a human being spins a flywheel at about 600 RPM to store energy. The energy achieved by paddling will be stored in a flywheel at an energy-input rate convenient to the peddler. After storing the maximum possible energy in the flywheel, the same will be made available for the actuation of process unit. The stored energy in the flywheel will be made available through a suitable clutch and torque-amplification if needed. The flywheel speed will be decreased depending on the actual resisting torque offered by the stir-up making process. It implies that it will not be necessary to pedal when the flywheel will be supplying energy to the process unit.

Figure 1. Stirrup Holding bar of Column and beam

1. Traditional Method of Manually Stirrup Making

Presently the stirrup are made up of the manually operation generally uses the M.S. Round bar of the size 6mm, 8mm are cut . The operator uses the wooden block to perform the bending operation; the wooden block contains the three holes alternately drilled on the wooden block. The stirrup wire is horizontally passed through the nails up to the chalk marks & then operator bends it into the 90 degree. It is operation performs 03 times to get the desired stirrup in perfect 90 degree. The chalk marks are made up for the purpose of size of the stirrup. His way with the help of the manual efforts the stirrup are Produced.

Figure 2.Concrete block as a platform for stirrup making

1.1 Material Used for Making of Stirrup

i) Mild Steel
ii) Torr Steel
iii) Thermo Mechanically Treated Steel (TMT)

1.2 Generally Used Sizes for Making of Stirrup

Sr.no	Size of Stirrup	Diameter of rod	Material of rod
1	179 mm X 229 mm	6 mm	MS
2	229 mm X 229 mm	6 mm	MS
3	229 mm X 229 mm	6 mm	TMT
4	459 mm X 536 mm	8 mm	TORR

1.3 Technical Data for stirrup Making

Sr. No	Particular	Remark
1	Commonly used sizes of the Stirrup (in mm)	178 x 178 , 229x178, 305 x 229, 305 x 305, 229 x 381,
2	Commonly used shapes of the Stirrup	Square, rectangle, round, pentagon , triangular ,
3	Commonly used sizes of the Stirrup wires (in mm)	6,8,10,12
4	Percentage utility of the stirrup of various shapes	Square :-55 % Round 9 % Rectangle :35% other 1 %
5	Percentage utility of the stirrup material	Plain M.S. Bar 65 % Tool Steel bar 35 %s

The details study of manual stirrup making indicates that the process suffers from the drawbacks like of accuracy, low productivity and resulting into sever fatigue in the operator. The construction worker not only subject their hard work to hours of repetitive motion but also sometimes suffers internal injury to his body organ i.e. disorder carpel tunnel syndrome CRS. Many researchers have carried work in order to reduce musculoskeletal disorder.

Figure 3 Traditional method of stirrup making

2. Basic Concept of HPFM Stirrup Making Machine

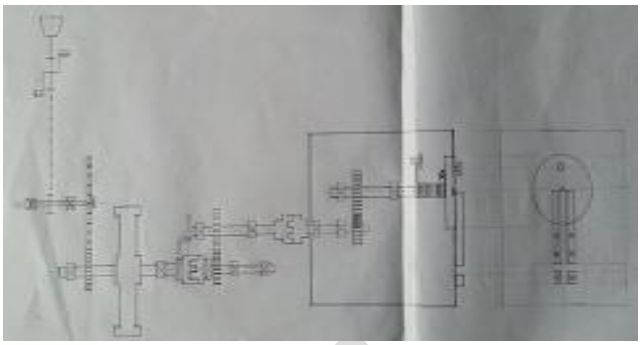

Figure 4 Schematic arrangement of HPFM for Stirrup Making

1-Chain Sprocket 2-padel. 3-Chain 4-Freewheel 5, 6-Bearing for bicycle side 7-Gear I 8-Bearing 9-Tachogenerator for flywheel shaft 10- Pinion I 11-Bearing for flywheel shaft 12-Flywheel 13-Bearing for flywheel 14-Two jaw clutch 15, 16-Bearing for intermediate shaft 17-Pinion II 18-Gear II 19, 20-Bearing for process unit shaft 21-Coupling 22-Stirrup making process unit.

The schematic arrangement of human energized flywheel motor stirrup making machine is shown in Figure 3. The operator drives the flywheel (12). The rider accelerates the flywheel to a desired speed in about one minute , through a chain (3) and a pair of gears (7,10) .The chain drive is utilized for first stage transmission because the drive is required to be irreversible, this is achieved by conventional bicycle chain drive with a free wheel (4). A free wheel is used between pedals (2) and the flywheel to prevent the back flow of energy from flywheel to pedals. When flywheel attains desired speed, pedaling is stopped and it is connected to the process unit though torque amplification gears by engaging a two jaw spiral clutch (14). A special jaw clutch is used in this machine in place of conventional friction clutch as friction clutch consumes more energy for its own operation. [7] The energy stored in flywheel is supplied at the required rate to stirrup making unit. (22).

2.1 Specification of Energy Unit for stirrup making

Following Material is required for fabrication of Energy unit for stirrup making.

Sr. No	Name of Parts	Material	Standard Size	Quantity
1	Cycle Frame	Std.	As per std.	1
2	Large Sprocket	Std.	D = 175 mm	1
3	Chain	Std.	L = 2010 mm	1
4	Small Sprocket	Std.	D = 95 mm	1
5	Spur Gear (Big) 1	Std.	m= 6 kg Dia = 370 mm n =120 t = 25 mm	1
6	Pinion 1	Std.	m= 1.8 kg Diar = 103 mm n= 30	1
7	Shaft 1	EN-8	Dia= 30 mm L = 283 mm	1

8	Shaft 2 (Step Shaft)	EN-8	Dia= 40 mm L = 290 Dia = 30 mm L= 145	1
9	Shaft 3	EN-8	Dia = 30 mm L= 280 mm	1
10	Flywheel	CI	D = 515 mm, w = 75, t = 54 mm,	1
11	Clutch - C	CI	Do = 83 mm Di = 30 mm Width = 100 mm	1
12	Pinion 2	Std.	m= 1.5 kg Dia= 70 mm n = 20 t = 28 mm	1
13	Ball Bearing	Std.	UCP 210	7
14	Spur Gear- G1	CI	m= 1.5 kg Dia = 133 mm n = 40 t = 28 mm	1
15	Spur Gear- G2	CI	m= 2.2 kg Dia = 200 mm n = 60 t = 28 mm	1
16	Spur Gear- G3	CI	m= 2.2 kg Dia = 258 mm n = 80 t = 28 mm	1
17	Shaft – Sh1	SAE 1040	Dia = 30 mm L =500 mm	1
18	Shaft – Sh2	EN-8	Dia = 30 mm L = 510 mm	1
19	Shaft – Sh3	EN-8	Dia = 30 mm L = 510 mm	1

3. Fabricated View of human energized flywheel motor for Stirrup making machine

Figure 5: Fabricated View of human energized flywheel motor for stirrup making machine

Figure 6: Top View of human energized flywheel motor for stirrup making

4. Specification of Processing Unit (Stirrup Making Unit)

Sr. No	Name of Parts	Material	Standard Size	Quantity
1	Spur Gear 1	CI	PCD =130 mm n= 18 t = 30 mm	1
2	Spur Gear 2	CI	Dia = 170 mm n= 55 t = 30 mm	1
3	Shaft 1	EN-8	Dia = 30 mm L = 225 mm	1
4	Shaft 2	EN-8	Dia = 30 mm L = 280 mm	1
5	Rotating Disc	MS	Dia = 180 mm t = 18 mm	1
6	Rotating Pin	MS	Dia = 12 mm L = 50 mm	1
7	Coil Spring	As per Std.	Outer Dia = 45 Inner Dia = 43 Coil t = 2 mm w= 5 mm n= 14	1
8	Ball Bearing	As per Std.	Bearing No. UCP- 206	4
9	Coupling	Star L-100	Do= 65 mm Di = 30 mm t = 35 mm	1


Figure 7: Front & Side View of HPFM for stirrup making machine


Figure 7: Actual Photograph for stirrup making process unit

5. Operational step of HPFM Stirrup Making Machine

1) A person pedals the mechanism for about a minute with the clutch in the disengaged position. In this time the flywheel of about 0.515 m diameter and 0.075 m rim width can be accelerated from rest to about 600- 700 rpm. During pedaling he has to overcome only the inertia of the flywheel. The operator pedals for about one and half hours.
   After attaining the pre decided maximum flywheel speed pedaling is stopped. The clutch is immediately engaged and the energy stored in the flywheel is made available to the process unit through the clutch and torque amplification gears. The stirrup making process unit immediately commences upon the clutch engagement and it continues for 30-35 sec until such time as the flywheel comes to rest still follow steps 2,3,4,5.
2) First the small length of rod is bend which is called as anchorage length by pressing the clutch .This length is important for binding the stirrup to the column rods.
3) Then second bend is made according to size of stirrup by forwarding the required size stirrup length and pressing the clutch.
4) Similarly third and fourth bend is made to make the stirrup in shape according to each side of stirrup size by forwarding the required size stirrup length and pressing the clutch.
5) Finally the fifth bend is made in which other anchorage length is bend which is finally tied with the first anchor by pressing the clutch and stirrup is prepared.

II SCOPE OF THE WORK

Operation for making stirrup is tedious and required continuous manual work to perform the bending operation. This will minimize human efforts for less physical exertion of the operator.

- Adverse effect of repetitive work on human health is minimising.
- Reduce the wastage of stirrup and this will reduce the cost of stirrup making activity.
- There is a scope to design the stirrup with safety standards and with ergonomic considerations which will help to avoid the incidents during manually stirrup making.
- There is a scope to improve the stirrup making efficiency and production capacity of stirrup by using human powered flywheel motor of stirrup making.
- The currently available machines are motor power (electrical supply) operation machines and hydraulic type machine which cannot work where non availability of electricity.
- This research presents a new urge as method to bend the given rod of 6,8 mm diameter with the help of human power as a energy source for performing the job.
- This area is having a large scope because of construction in MIHAN & CARGO project, at the same time fast development in rural area.

CONCLUSION

- It is seen that process by human powered flywheel motor required less effort and reduced the internal injury of the workers.
- It is also reduce the human energy expenditure of workers.
- It is reduce cost of stirrup making activity.

So this paper gives detailed design, development and fabrication of human powered flywheel motor for stirrup making machine that is the best process as compare to present manual stirrup making process shown in figure 3

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