Design And Analysis Of Internal Expanding Jaw Gripper System By Using Mating Worm System

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Abstract - *Material handling process is a nonproductive process that adds to the product cost and is important to be done in shortest possible time with least amount of labour and time. The present pipe handling systems are in-efficient and unsafe and hence there is need of proper gripper system to ensure fail safe and quick handling of metal pipes in material transport. The internal expanding jaw gripper is developed with the same objective where in the pipe to be transported is held between the fixed jaw and moving jaw to crease a failsafe grip that does not loosen even if there tension in the loader arm is reduced. The gripper system is quick in action and provides safe grip. Safe grip means that the gripping force exceeds the effort applied in gripping. The object of project is to test and evaluate performance of this gripper as to minimum and maximum size of object to be clamped, time taken in clamping, de-clamping and the failsafe gripper force value.*

***Key Words*: Internal expanding jaw, failsafe grip force**

1.INTRODUCTION

Material handling is the basic activity of every manufacturing organization. It has been estimated that unnecessary cost of the product is attributable to material handling activities. Unlike many other operations, material handling adds product cost and not to its value. So first is to eliminate or minimize the need for material handling and second to minimize the cost of handling. Presently the metal pipes are handled manually by use of crow bar and human labour, which is time consuming, damages the pipes while transportation, unsafe work practice hence there is a need of pipe gripper arrangement for fast and safe handling of concrete pipes and concrete rings. Labour safety conditions highlight the use of pipe gripper / holder to ensure that the pipe does not slip while in motion. Lifting and placement of the pipes can be managed safely by the use of an internal expanding jaw pipe gripper equipped by jaws that hold tight and do not loosen under the action of load. Light weight, structure is simple, so the usage of it is very favorable. The concrete pipe can be kept by turning the Hanging force into clamping force. The holding mechanism is self-adjusting in the defined range of the ring thickness, so set-up is not necessary. However the ring thickness requires any adjustment, it can be set up by the screw spindle in the dual wing joint. Because of the safe grip the clamping jaws are knurled. The system pipe suspender gripper comprises of two jaws coupled by chain mechanism to the crane hook. The pull in the chain mechanism is converted into clamping force between jaws by the clamping system.

2. PROBLEM STATEMENT

Presently the concrete pipes are handled manually by use of crow bar and human labor, which is time consuming, damages the pipes while transportation, unsafe work practice hence there is a need of concrete pipe suspender for fast and safe handling of concrete pipes and concrete rings. The clamping in the case of the below twin jaw gripper that is presently used is a function of the pull force applied to the pull tie rod attached to one of the jaw arms but sometimes the tie rod pull force may reduce and become insufficient to Grip the object in the jaw owing to the slack in the pull chain attached to the tie rod, this may lead to slipping of the gripped object further leading to accident that may lead damage to work-piece / property or human life. It is important to keep the pipes and rings properly by lifting the concrete pipes and concrete rings. If the tool is prepared incorrectly, it may cause partial or total damage of the pipes or rings. Labor safety conditions highlight the use of concrete pipe suspender, concrete pipe holder, fount pipe holder and fount pipe suspender that have proper capacity. Lifting and placement of the concrete pipes can be managed safely by the concrete pipe suspender equipped by jaws. Light weight, structure is simple, so the usage of it is very favorable. The concrete pipe can be kept by turning the hanging force into clamping force. The holding mechanism is self-adjusting in the defined range of the ring thickness, so set-up is not necessary. However the ring thickness requires any adjustment, it can be set up by the screw spindle in the dual wing joint.

3. LITERATURE REVIEW

An exhaustive literature review is carried out to understand the present practices and theories in jaw lifter system design. It will also help to obtain a better understanding of how individual internal components and internal flows had been designed and modeled in the past. Wiktor W Panjuchin has done research on self-locking worm system with parallel axes to find high efficiency drive and provide instantaneous self-locking. (1)

Alex Kapelevich and Elias Taye have discussed variety of self-locking solutions with their specific applications. a principle of work of the self-locking gears has been described. Design specifics of the self-locking gears with symmetric and asymmetric profiles are shown, and testing of the gear prototypes has proved relatively high driving efficiency and reliable self-locking. (2)

Tudor Deaconescu has done modeling and simulation of the dynamic behavior of the pneumatic muscle and they are presented together with the study of the influence of air feed pressure on the behavior of the developed assembly. He found that by adequate selection of working parameter values the optimum variant of the gripper is obtained. (3)

Madhusmita Senapati has considered gripper as a class of unknown nonlinear discrete-time system. The gripper mechanism is implemented for unscrewing a square headed screw on the wall-tiles of a fusion reactor vessel. Various stages of this handling task are explained in detail with theoretical modeling. (4)

4. EXPERIMENTAL SET UP AND PROCEDURE

The set-up consist mainly of the following Components:
1) Fixed Bottom jaw 2) Movable Top jaw
3) Mating worm 4) Lever 5) Column
6) Hydraulic cylinder 7) Handle 8) Oil
9) Base plate 10) Display panel

4.1 Experimental Set Up

Fig- 4.1: Actual Experimental Set up Internal Expanding Jaw Gripper System

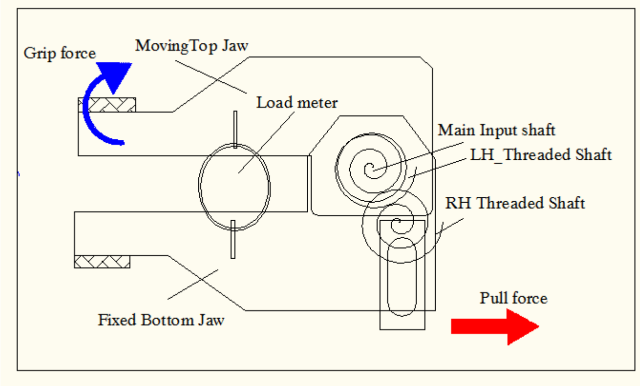


Fig- 4.2: Set up Diagram of system

The working of the above set up is as follows:

1. Place the jaw gripper in the internal diameter of the pipe.
2. Operate the pull force linkage with suitable pulling arrangement chain or pull rod.
3. The motion of the pull linkage activates the RH threaded shaft that is in constant mesh with the LH threaded shaft.
4. The motion of the LH threaded shaft makes the RH treaded shaft to rotate, but in opposite direction.
5. The motion of the RH threaded shaft is transferred to the moving top jaw that will expand in the direction shown in figure.
6. This motion of the Top jaw will ensure a grip force on the internal diameter of the pipe.
7. The action of the LH and RH threaded shafts is self locking, i.e. RH shaft cannot rotate the LH shaft even under load conditions ensuring that the pipe does not slip while in motion.

4.2 Schematic of Test rig to test the performance of the internal expanding jaw pipe gripper

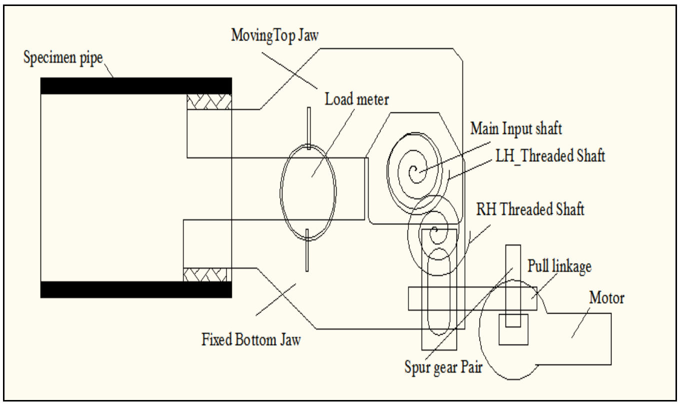


Fig- 4.3: Test rig for performance evolution of Internal Expanding Jaw Pipe Gripper

Procedure of Trial:

1. Start motor to move the pull linkage via spur gear mechanism for one rotation of the spur gear.
2. Take reading of the expanded jaw to check the expansion capacity of jaw to find minimum and maximum capacity of jaw gripper.
3. Place work piece in the jaw gripper inside the internal diameter of specimen pipe.
4. Start motor to move the pull linkage via spur gear mechanism to pull the effort arm and there by expand the top jaw.
5. Note the load meter reading
6. Repeat readings.
7. Note the maximum load application ability and maximum no slip load.

4.3 Observation Table - Clamping Range

Table -1 Clamping Range

Rotation of Spur gear	Jaw opening (Clamping capacity)mm
01	130
02	146
03	158
04	165
05	174
06	186
07	192
08	204

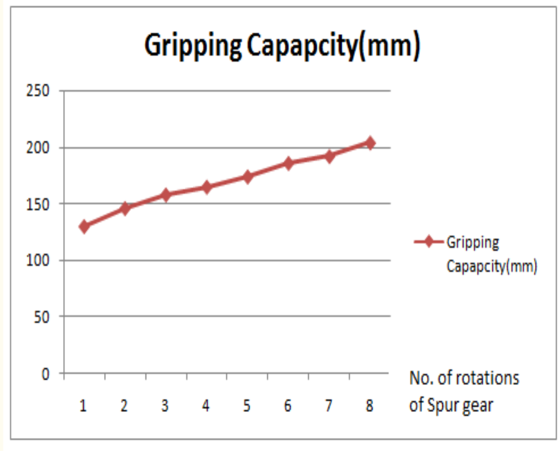


Chart -1 Gripping Capacity Vs No of Rotations

4.4 Observation Table Cycle Time

Table -2 Cycle Time

Rotation of Spur gear	Jaw opening (Clamping capacity)mm	Gripper time of operation (seconds)
01	130	0
02	146	8
03	158	13
04	165	19
05	174	21
06	186	26
07	192	32
08	204	35

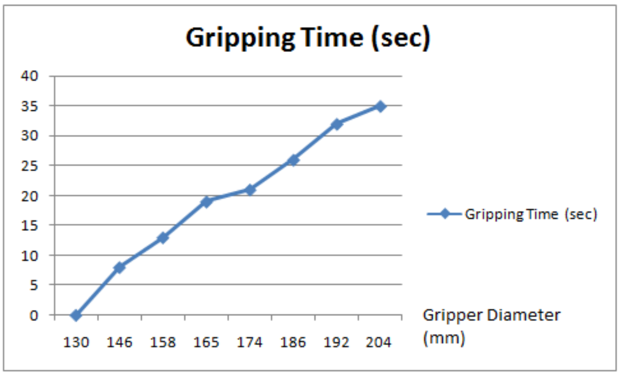


Chart -2 Gripping Time Vs Gripper Diameter

4.5 Observation Table Load Capacity

Table - 3 Load Capacity

Pull link displacement (mm)	Load meter reading (gripping force) kg	Spring balance reading (for jaw grip force)kg	Slip
01	0.9	1.4	0
02	1.6	2.1	0
03	2.9	3.4	0
04	3.4	4.1	0
05	3.9	4.9	0
06	4.6	5.8	0
08	5.8	7.3	0

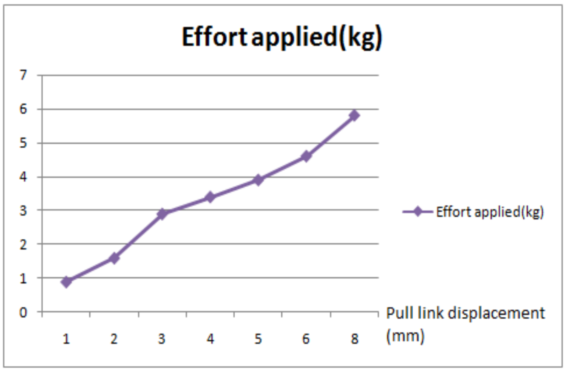


Chart -3 Effort applied Vs Pull link displacement

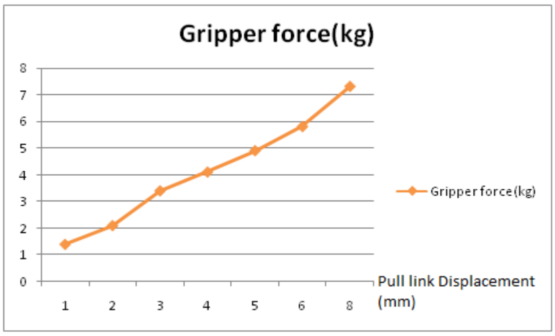


Chart -4 Gripping of Gripper force Vs Pull link displacement

4.6 Validation of Gripping force produced by self-locking gripper for internal pipes.

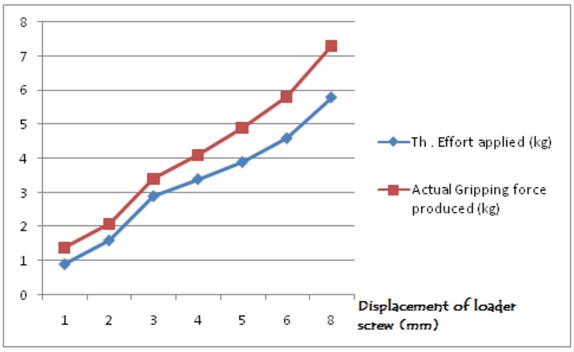


Chart -5 Graph of Th. Effort applied vs Actual gripping force produced

5. DESIGN

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy and efficiency. Hence a careful design approach has to be adopted. The total design work has been split up into two parts;

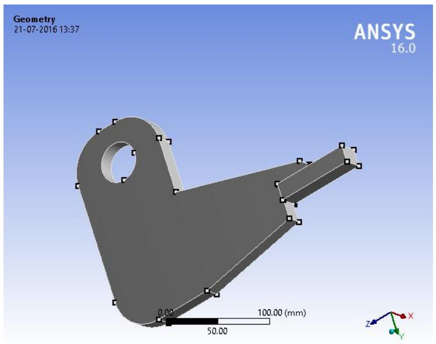
5.1 System Design

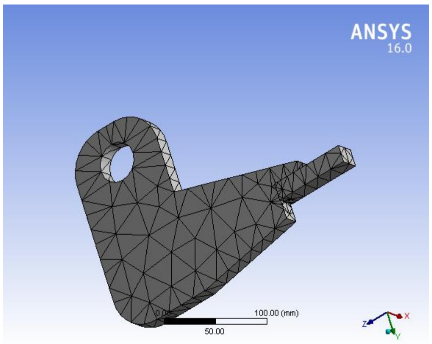
System design mainly concerns with various physical constrains, deciding basic working principle, space requirements, arrangements of various components etc.

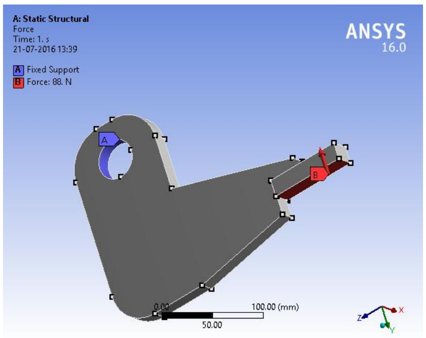
5.2 Mechanical Design

In mechanical design the components are listed down and stored on the basis of their procurement in two categories,
1) Design parts.
2) Parts to be purchased.

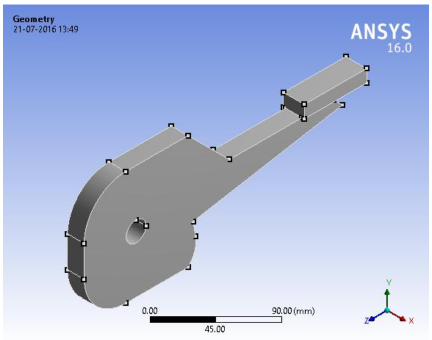
5.3 Analysis: (Modeling, Meshing, Static Structural) of Bottom Fixed Jaw

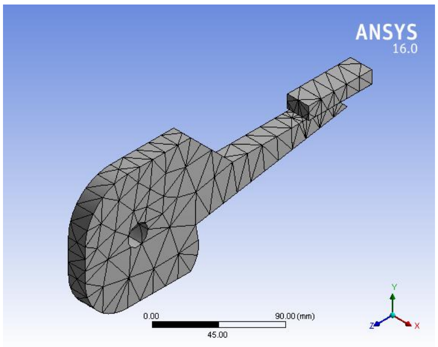


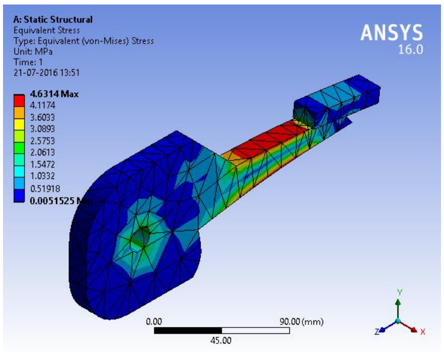




5.4 Analysis: (Modeling, Meshing, Static Structural) of Top Movable Jaw







6. RESULT AND DISCUSSION

1. The gripper shows minimum clamping capacity of 130 mm and maximum clamping capacity of 204 mm thus it can be said that the gripper has clamping range of 130 to 200 mm.
2. Gripper shows minimum clamping time of 8 seconds for capacity of 130 mm and maximum clamping time of 35 seconds capacity of 204 mm thus it can be said that the gripper has clamping time range of 8 to 35 seconds for zero to max jaw opening.
3. The Gripper shows a effort application range of 0.9 kg to 5.8 kg for pull link displacement 1mm to 8mm
4. The Gripper shows a gripper force range of 1.4 kg to 7.3 kg for pull link displacement 1mm to 8mm
5. The theoretical effort applied by the loader screw is always less than the actual gripping force produced indicating that the work piece will is secure held in jaws.
6. The graph indicates zero percent slip for all values of the applied gripping force. Showing 100 % efficiency of device.
7. Percentage slip is zero for all readings of loader screw displacement.
8. As all results indicate that there is no slip , our hypothesis that the self-locking gripper produces gripper force more that the applied effort t so that the work piece will not slip from the jaws at all condition of loading.

Thus it is safe to conclude that the self-locking condition is achieved effectively and the experimental results are validated as all the gripping force values are well above the theoretical effort applied.

From this new designed gripper system we get following benefits:

1. Maximum gripping force from the gripper system.
2. Self-locking characteristics.
3. Reduced power consumption.
4. Reduced cost.
5. Secure and safe clamping.

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