

Design of Zip Chain Lifters

Pradeep Kapri, Vikas Tiwari, Paresh Choudhary, Prabhakar Nikam

Abstract: Conventional method of lifting include lifting the weight by the help of cranes, forklift or by any type of lifting mechanism. A major problem in lifting and lowering applications is moving loads at a linear rate while maintaining steady and level positioning on vertical and horizontal plane. The factors considered while lifting any object is the durability of the lifter as well as the time and speed required to lift the object. Zip chain lifter employs a lifting mechanism that uses zip chain to directly transmit upward and downward thrust, thus lifting the object. The zip chain lifter consists of chain and sprockets mechanism for transmission of motion and force from one part to another. When lifting, the Zip Chain Lifter engage two zip chains to form a strong, rigid, column-shaped body that pushes up the platform while when descending, the chains are unlinked and moved in a compact housing. Powers are transmitted through a single strand chain when the driver sprocket rotate and the teeth interlock the chain, pulling the chain around it causing it to rotate.

Keywords: Mechanism, sprockets, chains, lifters.

1. Introduction

Lifting operations are intrinsic to many occupations in the construction industry. They can be performed manually or by using any type of lifting equipment. Both manual lifting and mechanical lifting operations can put construction workers at great risk of live causing sick leave or disability. A lifting operation is concerned with the lifting and lowering of load. There are various type of lifting equipment such as cranes, forklift, hoist, hydraulic lifters etc.; which are used for lifting and lowering of load however the equipment used depend on the type of the application. All the equipment must satisfy the factors which are essential for lifting the load such as it should have high speed, long life durability, ease of installation, greater thrust efficiency etc. Zip chain lifter use zip chain and sprocket mechanism to lift and lower the load accordingly. It is so named because it consists of two chains that interlock in zip-like fashion to form a single, strong column. Ordinary chain is used for pulling purpose, it is not capable of transferring power when pushed, while zip chain can be used for both the pushing and pulling application. The zip chain lifter has simple structure, better stability and higher reliability.

1. Chain and Sprocket Mechanism

The yield from power source such as wind generators, turbine, and electric car is rotary motion of drive shaft. The out-turn rotary movement and force must be transmitted from power source to a machine by the help of mechanism that will use the energy in some way. For this purpose different type of mechanism is used out of which one is the chain and sprocket type mechanism. A Sprocket has projected tooth wheel that fit into recesses of chain which is used to pass the motion and torque from one shaft to another. A chain is made

up of series of link with the link held together steel pin.

- Department of Mechanical Engineering, Thakur College of Engineering and Technology, pradeepkapri7@gmail.com
- Department of Mechanical Engineering, Thakur College of Engineering and Technology, tiwarivikas103@gmail.com
- Department of Mechanical Engineering, Thakur College of Engineering and Technology, pareshc123@gmail.com
- Department of Mechanical Engineering, Thakur College of Engineering and Technology, prabhakarnikam17@gmail.com

Together chain and sprocket work as a mechanism for power transmission. The number of teeth between the driven and driver sprocket determine the speed and torque of the chain and sprocket mechanism. The contour action of the chain link causes some frictional losses between sprocket and chain; henceforth for this purpose lubricants are used. Power is transmitted through a single strand chain when the driver sprocket rotate and the teeth interlock the chain, pulling the chain around it causing it to rotate. The chain drive uses the engagement of sprocket teeth and chain to drive it.

2. Design of zip chain lifters

Zip chains are two strand of chain that interlocks in a zipper like fashion to form a single, strong column that enables push/pull operations over long stroke. The unzipped chain can be compactly housed for far more space savings than with pneumatic and hydraulic cylinders. It has simple structure, better stability and higher reliability. The design of zip chain lifter consists of zip chain, sprockets and bearings and rollers. Zip chain lifter is an innovative lifter that directly transmits lift thrust through zip chain. The material used for the manufacturing of chain and sprocket depend upon the torque and power need to be transmitted, generally the metals used for manufacturing are alloy steel and cast iron with suitable alloy properties followed by the heat treatment for tempering and case hardening the equipment. Zip chain lifter is so named because it consist of two zip like chain that interlock between to form a single column like structure for support of scissors bearings and rollers. Zip chain follows mechanism that transmits drive force more efficiently than electric/hydraulic lifters.

3.1 Components

Component	Types
1.Chains	Zip chain
2.Sprockets	Double pitch chain sprocket
3.Drive motors	Servo/Induction motors
4.Lift	Scissor Lift
5.Base plate	Metal slab



Fig 1. Zip Chain Lifter

4. Working of zip chain lifter

The zip chain lifter is a new lift table that maximizes the zip chain and sprocket mechanism to move it forward and backward. This Groundbreaking, Electrically driven lifting mechanism gives multiple time the energy efficiency compare to conventional hydraulic lifter. The working of zip chain lifter is basically dependent on the chain and sprocket mechanism, the zip chain is mounted over sprocket which rotates both anticlockwise and clockwise direction to provide forward and backward motion. The sprocket rotate and Zip chain interlock to form a strong column support which is used for upward motion or lifting of the object. This continuous rotating motion of sprocket moves zip chain upward and backward. The zip chain is provided with scissor metal lifter and roller bearings to provide the required support for the lifting or lowering of load. Zip Chain lifter is used to lift or lower the load by the application of Zip chain, sprocket and electrically driven mechanism. Once the motor is supplied with power, it start rotating the sprocket and the chain from the housing get locked in the space of sprocket thus lifting up the slab along with the zip chain .The roller support at the end provide the required support for the base (on which load is kept) to lift or lower the load, also it act as a compact spacing henceforth providing a better stability and reliability.

4.1 Drive unit

The drive unit consists of zip chain, sprockets and motors. The engagement of the zip chain and sprocket with projected teeth transmit power efficiently. The sprocket teeth get engaged in the spaces of zip chain for pushing and pulling operation powered by servo/induction motors for rotation of sprockets. Compare to conventional hydraulic lifter the zip chain lifter is superior because of it high speed, high frequency operation. Zip chain lifter uses the truss principle (i.e cross

sectional arrangement of metal strand) for the extra support required to lift or lower the load. In drive unit instead of sprockets pin gears can be used provide the gear teeth should be equally meshed with the spacing of zip chain. The sprockets can be rotated in both the clockwise and anticlockwise direction with the help of D.P.D.T switches.

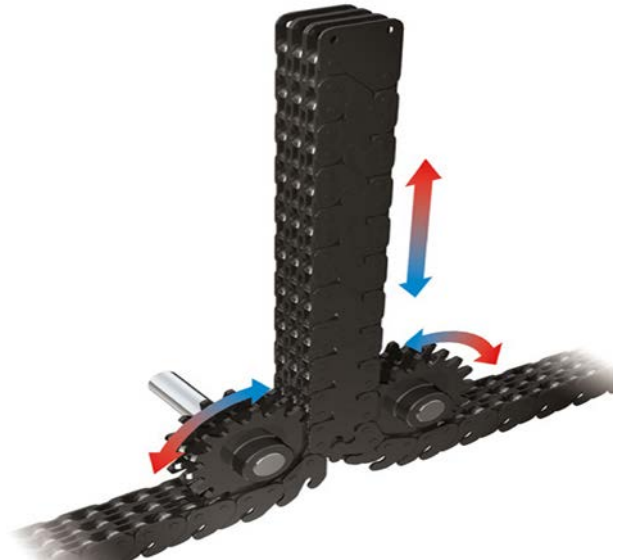


Fig 2. Chain drive section

Lift speed is directly proportional to the motor rotation speed. The speed is constant throughout the stroke range. High speed vertical conveyor with special zip chain provides and optimized flow line in the work place. Basically a chain with two chains of geared zippers is used to push and pull load up and down.

5. Literature Review

Zip chain lifter is a two chain fragments combined in a zip style to become a single strong column which performs push and pull operations. The conventional hydraulic system was quite slow in terms of lifting the objects and had oil leaks and other drawbacks associated with it. These gaps are fulfilled using this mechanism. As this system is purely based on the zip chain no condition of oil leaks is possible in this case also the speed of lifting operation is improved consistently. This whole system is basically uses tsubaki chains to lift the load. Primarily tsubakimoto a private enterprise manufactures the bicycle chains later started manufacturing other products such as roller chains, sprockets, cable carrier. The other products which are primarily associated with chain company now taken various forms. Being one of the leading suppliers of material handling systems use of the chains in lifter mechanism is came into the picture .the whole operation is also connected to power transmission system in the processing systems. The previous terminologies include horizontal rammer innovated and developed by Eldridge E. Long getting patent for "Lifting Jack". Also Yaichi Hayakawa for interlock chain processing which comprises the interlocking connections of the roller chains. This small terminologies transformed into the chain actuator.

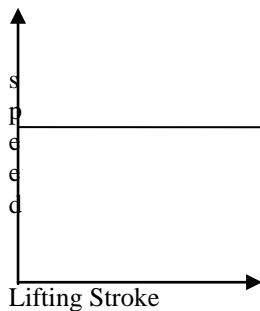
Also due to the complex structure three chain actuator is not developed yet.

6. Features

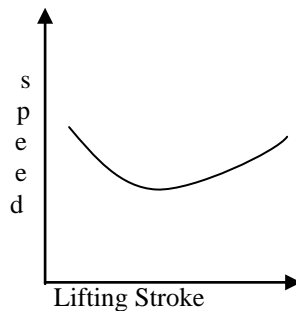
- **Excellent Speed and Position Control**

Zip chain uses the simple multi stage control mechanism. In zip chain lifter the speed is same throughout the stroke range hence it follow a constant path of speed. The positional accuracy of zip chain lifter varies within +/- 1. Arranging multiple stops and multi-level positioning can be easily done. High repeatable stopping accuracy at many points.

Tsubaki Zip Chain Lifter



Hydraulic Lifter



- **High speed and high frequency operation**

The zip chain lifter operates multiple times faster than hydraulic lifter. The mechanism provides greater stability thereby enhancing the rate of frequency of lifters. In hydraulic lifters due to increase in oil temperature it need to be hold down for few minutes or second to get the oil cool, thus limiting the frequency operation. While in case of zip chain lifter no such obstruction are observed.

- **Greater thrust efficiency**

Driving force is transferred directly since the zip chain mechanism pushes up the platform instantly. A minimal load is placed on the roller bearing and hinges. While in case of hydraulic lifter a large amount of thrust is needed at starting as the cylinder pushes the bar in oblique direction. Zip chain instantly pushes the platform so that motor toque can be transmitted without any losses.

- **Energy efficiency**

As compared to conventional lifting method zip chain lifter are more efficient. In a way it can provide much higher speed and high operational frequency limiting the losses. It also features a regeneration unit that returns some amount of energy produced when the platform is lowered to the primary power system, allowing the lifter to recover 30 percent of electricity consumption. The Zip chain lifters are more energy efficient in terms of transmission efficiency as it uses the diagonal push of hinges to support the platform carrying load.

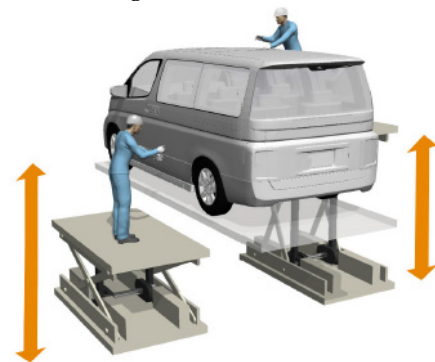
7. Limitation

- The chain drives need accurate mounting and maintenance, particularly lubrication and slack adjustment.

- In an extreme condition the chain might get break due to certain expansion or contraction in drive.
- It cannot work without electricity supply, since the rotation movement to sprocket is provided by motors.
- The size of zip chain and sprocket limit the application as for varying loads, size of zip chain and sprocket will varies accordingly.

8. Application

- Zip chain lifter can be installed on an automated guided vehicle with small footprints.
- Lateral pushing and lifting of components.
- Operator lifter.
- With the high durability and ease of application it can be used in any machinery for lifting or pushing the load.
- To lift or lower the loads.
- With increase in number of chains and sprocket extra support can be provided for lifting or lowering of loads.



9. Conclusion

The zip chain lifter follows the most convenient and simplistic approach compared to other lifters used in industries. The compact ability and high durability with ease of application maximize the application of zip chain lifters.

- This technique directly transmits the lift thrust using the zip chain.
- Although this technique is quite efficient and easy to operate it covers most of the drawbacks of the conventional system. It is clear that it can perform high speed and high frequency operation much better than manual lifting.
- As the paper has demonstrated various merits and demerits of this system but these flaws can be avoided by timely precautions and handling.
- While the key emphasis appears to be great thrust efficiency from industrial application perspective.
- In addition, high durability increases the life of

the zip-lock and sprocket mechanism.

- Since the industries already had a hydraulic process for lifting operation, it is possible that zip lock mechanism could cannibalize the industrial environment and lifting operations.

10. References

- [1] Haribaskar,G, Dhenesh Kumar,N, Arun Kumar,C, Hari Haran,P, Boobalan,M, Sadha Sivam, "Remote Controlled Scissor Jack to lift the Vehicle", International Journal of Advanced Research, 2015.
- [2] "Design, Manufacturing & Analysis of Hydraulic Scissor Lift",Gaffar G Momin, et al, International Journal Of Engineering Research And General Science Volume3, Issue 2, Part 2, March-April, 2015.
- [3] "Chains and classification of chains", by Mr.S.S.Ratan , Theory of machines by Tata McGraw hill publication Fourth edition pg no 325-329.
- [4] "Chain and gear (sprockets) mechanism", by Mr.V.Ryan, technologystudent.com.
- [5] Zip chain lifter, Tsubakimoto.com/materials-handling.
- [6]