Metallic Scrap Processing with Bar Untangling Machine Designing

DARSHAL PATEL[1], Prof. KALPANA SAINI[1](Assistant Professor)

[1]Department of Environmental Engineering,
Swarnim Startup & Innovation University, Gandhinagar-382420.

Abstract : Worldwide, construction and demolition waste is becoming a threat for many environmental problems. Construction and demolition waste frequently makes up 10 to 30 percentage of the waste dump at many landfill sites around the world. Metal bars form demolition sites are usually collected and sent to scrap sites where it is melted down and turned back into new reinforcing bar. Reuse of metal bars is better option than recycling. There are machines developed by various industries to straighten drawn and coiled metal bars, but the commercial bars available in the market have differing cross section and material properties. Nowadays straightening of these commercial bars are done manually in industries by hammering process. It is a very tedious job and time consuming too. So there is an industrial necessity to automate the process. In metal bar straightening method metal bar is straightened by transporting the metal bar between a pair of fixed and adjustable rollers. After conducting the straightening process for MS bars of 10mm diameter, a precision of was achieved. Autorotation of bar was prevented using the three roller standstill locking mechanism. Using ANSYS software for analysis, it was found that during the straightening process the bar undergoes maximum deformation at the centre portion whose value was within the allowable range for the combination of four fixed and three adjustable rollers. The stress developed in the bar was well within the permissible limits for steel material. The results show that the propose mechanism of straightening system is feasible and it provides favourable theoretical foundation for the development of commercial bar straightening machine. Reuse of metal bars generated from construction and demolition waste after straightening can also reduce the need for new landfills and that can also conserve the landfill space hence, proposed mechanism is also environment friendly.

***IndexTerms* - Standstill locking mechanism, autorotation, springback effect, elastoplasticity, elastic recovery torque.**

INTRODUCTION

C&D waste management:

There are four types of services where CDL waste is treated:

1.Landfills – The minimum required method of waste disposal is at a landfill, where waste is concealed.

2.Transfer stations – A transmission station is a place where waste is stirred from collection vehicles to larger trucks for transport to a landfill, source-separated recycling station or material recovery station.

3.Material Recovery Station (MRS) — "Material recovery Station" is the general term used to describe a waste-sorting station where a variety of co-mingled CDL materials are sorted for recycling. At a MRS, a combination of mechanical and hand-separation procedures are used to sort co-mingled recyclables.

4.Source-separated Recycling Station (SRS) – These recycling amenities take a wide variety of materials that have been separated at the station for recycling (i.e., wood, metal). They are the low-cost disposal option. Depending on the type and quantity, some may purchase the material.

BENEFITS FROM WASTE RECYCLE & REUSE

Reduce Costs -Recycling, reusing salvaged building materials and lessening materials reduce cost of waste disposal costs and material expenses.

Marketing Opportunity -Waste prevention and recycling may be marketing tool to the growing number of potential clients interested in use of in green building technology.

Tax benefits -Client can take a tax deduction when donate the reusable building materials to a non-profit organization (NGO).

Reduce the Building's Environmental Impact -Preventing and recycling wastes:

Reduces reduction of natural resources.

Creates a lesser amount of pollution by reducing manufacturing and transportation-related emissions.

Uses less energy compared to many fresh material product during manufacturing processes.

Reduces greenhouse gasses by using a lesser amount of energy for manufacturing

Prevent waste from construction Waste prevention is more beneficial than recycling. Identifying potential waste early in the design process decreases waste generated during construction.

Design with standard sizes for all building materials. This avoids creating waste when regular sized materials are cut to unusual lengths.

Design spaces to be flexible and adaptable to changing uses. This avoids creating waste during remodels of old construction.

Design for deconstruction. Some of the principles include: the dis-entanglement of systems, materials bolted together instead of attached, a construction and deconstruction drawing, built-in tie-offs and connection sockets for workers and machinery, no risky materials and highly recyclable materials.

Reduce Carbon Footprint

With the warming trend has accelerated as well as resource prices rise, the human community is facing a serious challenge to sustainable development, greenhouse gases, energy and resource conservation has become the most popular topics.

Up till now, the manufacturer's power source still comes from coal as raw material of carbon-based resources (such as coal, oil, gas, and so on) at present, the resulting gas emissions accounted for more than half of the total global greenhouse gas emissions, that is, the carbon emissions are the most important factors affecting global warming. In machinery manufacturing, metal cutting process has the highest unit energy consumption.

Take typical processes such as milling, turning and other metal cutting for example, unit energy consumption account for 66~82 MJ/kg in numerical control machining process, 50% higher than the consumption by using the forming methods such as forging, casting and so on.

Furthermore, the energy consumption of coarse processing is about 60% of the total energy consumption, finishing even reached 95%. Obviously, research of the resource consumption, energy conservation and emissions reduction for the metal cutting process has enormous potential and ecological urgency.

Figure 1 tangled bar from C&D waste

EXPERIMENTAL SETUP

ABOUT MECHANISM:

In this project, the attention is focused on developing a technique to untangle commercial steel bars in an economical manner. There are machines developed by various industries to untangle drawn and coiled metal bars, but the commercial bars available in the market have differing cross-section and material properties. Nowadays untangling of these commercial bars is done manually in industries by hammering process. It is a very tedious job and time-consuming too. So, there is an industrial necessity to automate the process. The autorotation was solved by a three-roller standstill locking mechanism. During the process of untangling, bars rotate around, which causes out of the vertical of untangling surface and the untangling precision is assumed. Based on the theory of elastoplastic large deformation, elastic recovery torque during the setting out of coiled bars is analyzed in accordance with the triple-roller equal curvature rotation blocking untangling system. To solve the spring back effect bi-directional loading was introduced and this gave better results. The idler rolls rotate on needle bearings. Gearboxes are totally enclosed with hardened steel gears bathing in oil. The bars were untangled with good accuracy. Experiment setup details of the developed machines are as presented in Table 4.

Table 1 Specifications of mechanism

Details	Specifications
Diameter of bar	10mm
Material of bar	mild steel.
Length of bar	1500 mm
Designing software	Solid works
Analysis software	ANSYS
Material of machine	Mild Steel
Length of machine	1500 mm
Width of machine	505 mm
Roller Diameter	180 mm
Type of motor	High Torque brushless DC motor

Figure 2 shows the three-dimensional model of the untangling mechanism. It shows the positioning of components in the machine. It consists of seven rollers, a feed roller, a stand-still locking mechanism, a motor and a gearbox. The parts in the machine are mentioned in Table 5 with their part numbers. Motor and gearbox play the role of power transmission.

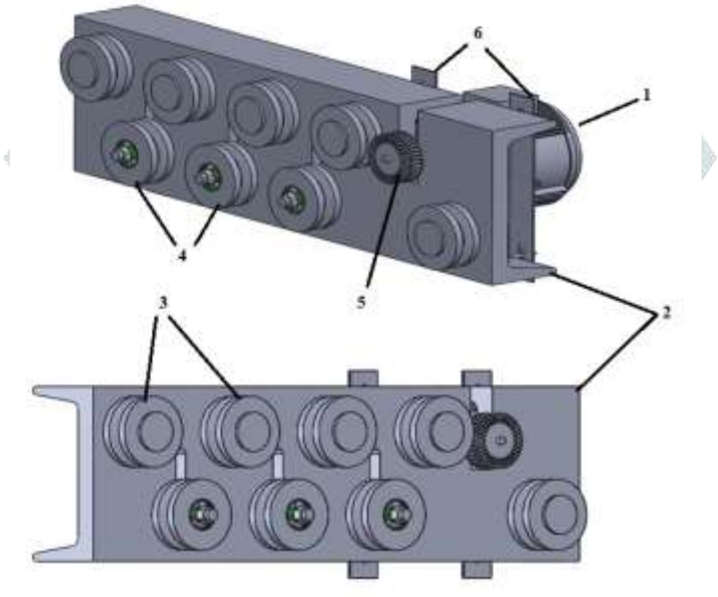

Figure 2 Three dimensional figure of the straightening mechanism

Table 2 Different components in the straightening mechanism.

Part number	Part Name
1	Brushless DC motor
2	Body
3	Fixed roller
4	Adjustable roller
5	Feed roller
6	Clamps

RESULTS AND DISCUSSIONS

The study was conducted to untangle MS bars generated from C&D waste. Solid works software was used to design an MS bar untangling machine. Rollers were used to remove the deformation of the MS bar. The tangled bar specimen is passed through the rollers. Autorotation of the bar was prevented using the standstill locking system. The mechanism contains four fixed rollers and three numbers of adjustable rollers in the upward and downward direction respectively as shown in Figure 6. The fixed rollers have enough power to guide the bars through the whole system. To obtain the optimum result from the experiment, the number of fixed and adjustable rollers were positioned in increasing order, and the results presented in Table 6. One pass of the bar takes around 10-20 seconds that implies the speed of the machine. The results obtained after passing the bars through the untangling mechanism results were shown in Figures 4-6. The experimental results depict that the combination of four fixed rollers along with three adjustable rollers furnished the best results as presented in Table 3 and Figure 3. After conducting the straightening process for MS bars of 10mm diameter, a precision of ±10 mm thick was achieved. Using commercial finite element software ANSYS, it was found that during the straightening process the bar undergoes maximum deformation at the center portion whose value was within the allowable range. The stress developed in the bar was well within the permissible limits for steel material. With the use of the proposed mechanism bar can be straightened up to 98% hence it is feasible. Figures 7 and 8 showing the diameter of the rollers, the gap between two rollers, the movement of adjustable rollers, and the dimension of the whole mechanism. Further, its straightening curvature of the bar has been shown in Figure 9.

Table 3 Accuracy in percentage with varying number of rollers

Design	Bar untangling
2 roller	10-20%
3 roller	25-35%
4 roller	35-45%
5 roller	65-75%
6 roller	75-85%
7 roller	90-98%

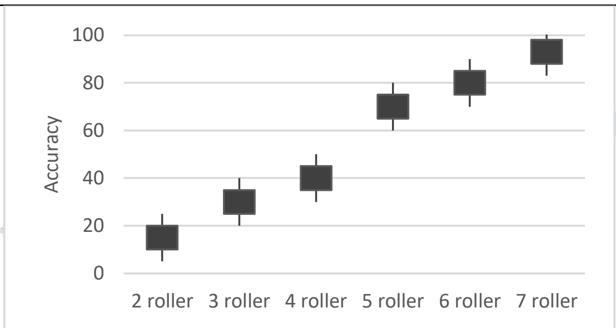

Figure 3 Graph showing accuracy with varying number of rollers

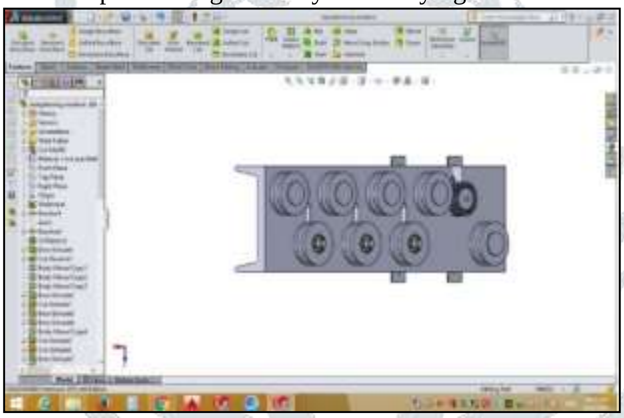
Figure 4 Final Design

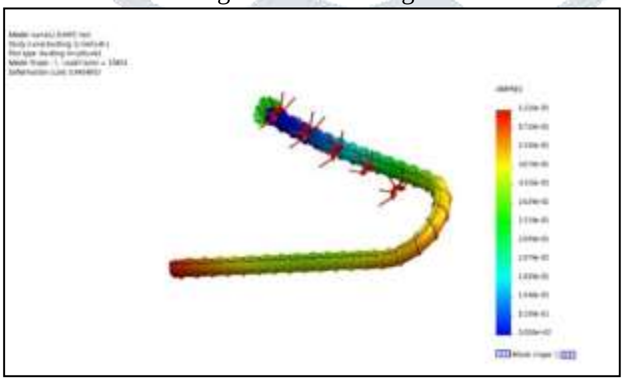
Figure 5 Bar before untangling

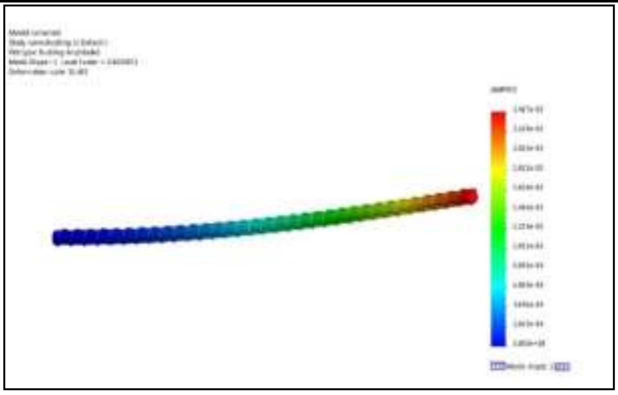

Figure 6 Bar after untangling

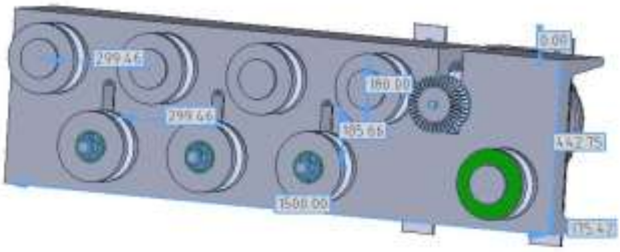

Figure 7 Front view of untangling mechanism with dimensions

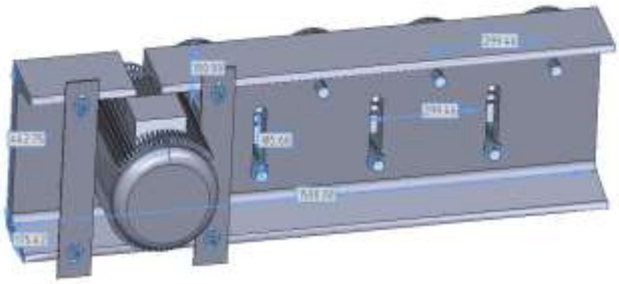

Figure 8 Rear view of untangling mechanism with dimensions

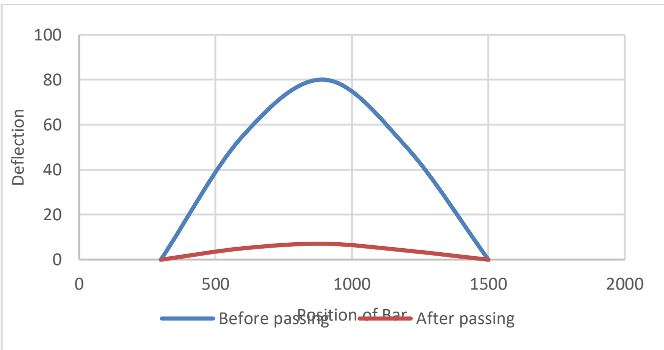

Figure 9 Straightness curvature of bar with 7 rollers

Analysis of carbon footprint:

During straightening of fresh bar (approx. 50 nos.) generates.

For straightening of 50 nos. of bar, fresh bar generates approx. 250 Kg CO2e while current mechanism generates approx. 150 Kg although melting process is not included in case of fresh bar. Carbon footprint is count by template of product GHC inventories by Qunatis US using Year 2014 US Regional Electricity Emission Factors for CO2, CH4 and N20 as base Data as presented in Figure 10

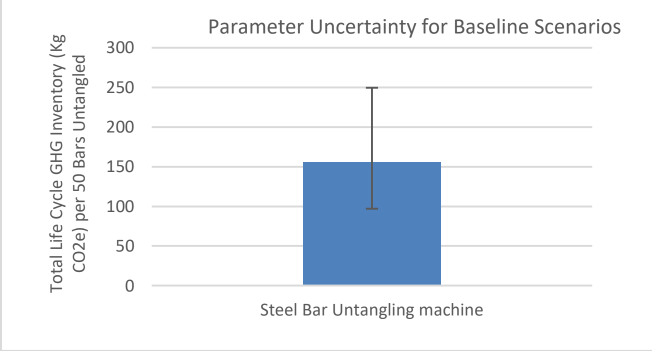

Figure 10 Carbon footprint count

Conclusion

Recyclability and reuse of metals are the key solutions to overcome the environmental impacts of construction demolition waste. Whilst this is a benefit, particularly in terms of material conservation and reducing raw material extraction, there is another, lower-impact option is material reuse. Straightening of metal bars is significant in reusing. This study aimed to review the existing methods to straighten the metal bars and tried to overcome their limitations. There are machines developed by various industries to straighten drawn and coiled metal bars, but the commercial bars available in the market have differing cross-section and material properties. Nowadays straightening of these commercial bars is done manually in industries by hammering process. It is a very tedious job and time-consuming too. So there is an industrial necessity to automate the process. In the metal bar straightening method metal bar is straightened by transporting the metal bar between a pair of fixed and adjustable rollers. Three power-driven fixed and adjustable rollers were used. The problem encountered during the process was the autorotation. During the process of straightening, bars rotate around the autologous axis, which causes out of the vertical of straightening surface and the straightening precision is deduced. To eliminate the auto-rotation of bars, three roller standstill locking mechanisms. Based on the theory of elastoplasticity large deformation, elastic recovery torque during the setting out of coiled bars is analyzed in accordance with the triple-roller equal curvature rotation blocking straightening system. The bars were straightened with good accuracy and the mechanism was analyzed using ANSYS. Best results were acquired by the use of four fixed and three adjustable rollers with an accuracy of 90 to 98%. The idler rolls rotate on needle bearings. Gearboxes are totally enclosed with hardened steel gears bathing in oil. To analyze the study on an environmental basis, the carbon footprint was also estimated and it showed that the untangling of bar reduces Kg/CO2e by 40%. Therefore, it shows its feasibility for sustainable environmental management.

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