STEEL RULE CUTTING DIE HANDLING

Term Paper

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Presented to

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Background

Steel rule cutting die is being used in many places to cut a range of sheet materials in their desired shape. At the author's organization, steel rule is used extensively to make a wide range of custom products. The author's organization makes corrugated boxes and displays. Steel rule cutting die enables the company to provide the customer with specialty custom designs. In the author's organization there are about 5000 die boards in-house at anytime. Each weighs about 20 to 30 pounds. Average size of the die is 3 feet by 3 feet. However, there are some over-sized, and can easily weight over 100 pounds and be over 7 feet. Hundreds of die boards are handled each day in the facility. Apart from the weight and size, the steel rule is sharp and must be handled with extreme caution. In this paper the author explores the HFE considerations in handling steel rule cutting die. The author also compiled a list of recommendations for his organization.

Steel Rule Cutting Die

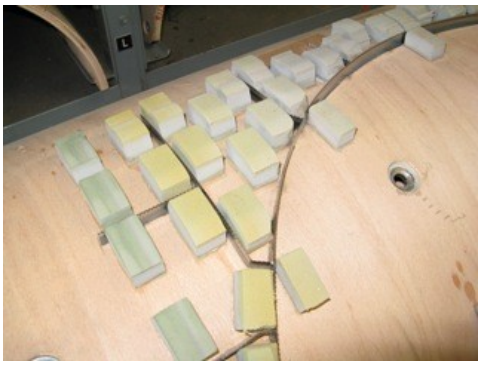
Steel rule cutting die is a common tooling used to cut sheet materials such as paper, rubber, and plastic. In the author's organization, steel rule cutting dies are used to cut corrugated sheets. Even though the cutting material is different the structure of the steel rule is the same. The backing of the cutting die consists of high density plywood --Birch wood is the most common material. By using the computer-aided drawing (CAD) software, designers plot the shapes into forms through the software onto to the plywood. With the latest technology laser cutter, being used to cut the holes for the steel rule insert. Steel rule is then bent according the CAD drawing and inserted onto the plywood. The last component for making a cutting die is rubbering. Rubber blocks are inserted next to the steel rule to ensure that the scrap from the sheets can be ejected successfully during high speed die cutting. The size and the weight of a steel rule cutting die vary depending on the final shape of the product. The smaller sized die can be 2 feet by 2 feet; the length of the bigger cutting die can exceed 7 feet.

There are three types of cutting die: rotary, flat, and stripping gigs. Rotary dies boards are shaped to fit the cylindrical die cutters. As the cylinder turns sheets enter the machine continuously through the die cutter. Flat die boards are used on platen die cutters. The shape of the die board, as its name suggests, is flat. Sheets enter the platen die cutting machine in a discrete manner. The die cutter takes one sheet, cuts it, releases it and takes another sheet. Stripping jigs are used in the machines with more automation. Older die cutters require manual work to strip the scraps off the sheets to reveal the final shape. A machine that

strips automatically uses set jigs to strip off excessive scraps and outputs the final product ready for the customer.

Rotary dies come in both full and partial. A full die board cuts a complete product using the same die board. A partial die board requires more than one die board to cut a product and often requires other functions of the machine to complete other functions of the machine. For example, a box with a hand hole uses hand hole partial products.

Rotary Cutting Die



Die Rubbering and Steel Rule

Example of a Partial Die, a Hand Hole

Process for Handing the Steel Rule Cutting Die

The process for handing the steel rule cutting die in the author's organization is not complicated. In fact, it is the same as handing any other supplies or tooling like ink or masking tape to anyone else. The considerations, however, come from the irregular shape and weight of the die which lead to HFE issues as well as safety issues. There are rooms for improvement.

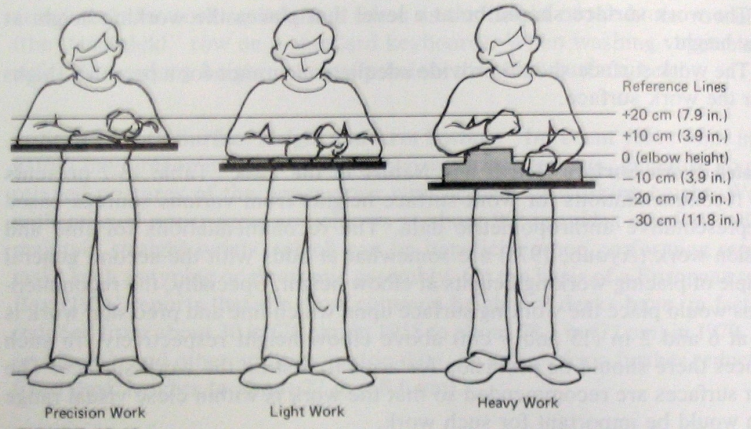
The die arrives from the outside vendor and steel die makers, via their transport truck. It is then moved to the receiving area by hand next to the technical department office. The reason for the location of storage area is that a signature is required for receiving by a technical worker. Upon the approval of the receiving and order, the worker at the production will take over the ownership of the die. The die puller at each shift will retrieve the die using a hand card and transport new dies into the storage area. When a die is being stored the first time the die puller would assign a die number as instruction by the technical worker and a location number depend on the availability. The die puller than writes the identification number on the side of the cutting die. Each rack space was marked by a location number. The storage was a pit in the corner of the production floor converted for the purpose of storing dies. Racks were set up on both sides of the walk way and there were two mobile stairs. Part of the storage area has tall roofing and has no lighting. Upon the assignment of the die number and the location number the die puller would store the die at the designated location, an open slot using two pins to hang the die. The die puller uses mobile stairs if the location is at the second or third level of the rack.

When an order is scheduled to run at a machine the die puller receives a line up two shifts ahead. He or she would look up the location of the die in the record and pull the cutting die from its location. He or she then manually moves the die onto the hand cart and pushes the hand card to the designated machine. The same procedure was done to retrieve the cutting die when order is finished. At the machine the operator mount the cutting die by picking the die up and mounting it manually onto the machine. The operator screws the die securely on to the machine using wrench and securing bolts.

The process was very simple however it is very easy to get injured while handling the cutting die. The die is heavy and the knife is very sharp. As a safety precaution coworkers at the author's organization are required to wear safety glove when handling cutting die.

Design Workplace to Fit Body

Several equipment/fixtures were used for the cutting die. The die table, moving cart, stairs for the storage area, and cutting die itself. These items should be designed to accommodate for human use. For example, the current die table area was far away and very small. A lot of the times the workers would work on a die elsewhere and not using the die table which is designed to handle the weight of the die. Working on the die elsewhere created a problem with workplace ergonomics. Working table for laying the cutting die should be sufficiently large to fit an average size cutting die. The operator should not lay the cutting die on a desk with smaller surface area or other desk that is not designed for the cutting die; which may lead not only to ergonomic problems but also safety issues. The height of the working surface should be the average wrest height. The operator should work in a standing posture to maximize the range of the both hands grabbing and reaching for the surface of the cutting die and the tools. Tools should be designed to allow one hand operation and automatic if possible. The working space should be sufficient enough to accommodate the operator while he or she is handling a cutting die.



Design Considerations for Work-Surface Height

TABLE 13-4
RECOMMENDED STANDING WORK-SURFACE HEIGHTS FOR THREE TYPES OF TASKS*

		Fixed height		Adjustable height	
Type of task (standing)	**Sex**	**in**	**cm**	**in**	**cm**
Precision work (with elbows supported)	Males	49.5	126	42.0–49.5	107–126
	Females	45.5	116	37.0–45.5	94–116
Light assembly work	Males	42.0	107	34.5–42.0	88–107
	Females	38.0	96	32.0–38.0	81–96
Heavy work	Males	39.0	99	31.5–39.0	80–99
	Females	35.0	89	29.0–35.0	74–89

* Assumes platform will be available to lift smaller users to proper level.

Recommended Standing Work-Surface Height

Die Table

The transport cart that is used to move cutting dies can also be a HFE consideration. Transport cart should provide easy loading and unloading without the operator having to handle a cutting die in an awkward posture. Current cart design is a front and back loading cart with side panels and the coworker has to stretch his or her hand in order to load or unload the cutting which creates unnecessary strain to the body. The organization could consider side loaded carts where the coworkers have a more balanced handling of the die making the loading and unloading easier and using less effort.

Cutting die itself can also incorporate design to make the material handling tasks easier. For example, there should be hand holes on top of the cutting dies where the workers can grab and lift the die in a more natural and balanced position. Some cutting die have no hand holes at all and some have only one. When a coworker is lifting a cutting die from the edge the weight may not be balanced on both sides. Instead, the center of the weight may shift to one side or another. The worker could lose balance and injure him/herself.

Load Handling

Cutting die is heavy and bulky and if the die is handled improperly, it can put a strain on workers because he or she has to stretch, move, bend or straighten their body unnecessarily. Handling material is one of the most frequent causes of injury and the cost to the human suffering can be significant. Most frequent injuries from handling the cutting die is lower back injury; in particular to the discs of the lumbar spine. The smaller dies were heavy still but easier to handle; however, it is harder to determine the center of the balance on larger dies and unexpected loadings may occur. The organization should provide training on how to properly lift heavy objective in particular the cutting die. In addition one should never attempt to lift large sized cutting dies by themselves.

Lean Manufacturing Consideration and HFE

While HFE concerns with the interaction of the human and the system and lean manufacturing concerns with the reduction of waste in the system how can both be interrelated. In the author's organization lean thinking is a major driving force to reduce cost and increase profit as the business is more competitive than ever. Lean manufacturing principles were also applied to the process of handling the steel rule cutting die. For example, the location system used eliminated the search time for the cutting die. The push system in the scheduling makes sure that the right tooling is at the right place at the right time, which reduces the machine downtime. 5S principles are applied everywhere at the workplace to increase the standardization of the processes. As a result, lean principles have made a direct impact on the HFE improvement of handling the cutting die. Before lean manufacturing was implemented, the storage methods were by tribal knowledge. Die boards were stored on top of each other and some die boards were stored in the hard to reach and unsafe areas. In terms of making a process lean, the time is wasted in searching for the cutting die. In terms of the HFE, there were concerns with improper handling of the heavy loads and or improper design of the workspace.

Disorganized storage reduces efficiency, increases risk of body injury

Environmental Conditions

Major factors considered a part of human factors in engineering for designing environmental conditions were: illumination, climate, noise, and motion. There were no special needs discovered during this study for the handling of steel rule cutting die except illumination. The illumination in the storage area is considered important since dies were store up to three levels high. The coworker has to identify the die numbers when looking for a die. Some areas were found poorly illuminated

An Organized storage with HFE design

Summary of Recommendations

1. Move the receiving area to the shipping duck instead of the office to reduce the material handling frequency and travel
2. Never lift cutting dies heavier than 50lb or longer than 6 feet along. Use 2 people.
3. Redesign the cart handling cutting die to load dies from the side to minimize body stretch and strain in loading/unloading dies
4. Provide back support and safety (cut resistant) glove for coworkers handling cutting die.
5. Upkeep the practice of 7S workplace organization of the lean manufacturing principle to reduce variation in handling cutting die and keep the workplace clean and organized.
6. Illuminate storage areas with illumination level of E or F to provide sufficient lighting. Use the scale adapted from Kaufan and Haynes in 1981

Conclusion

The handling of the steel rule cutting die may sound like the same as any other supply or tooling; however, steel rule cutting die is generally bulky an over sized for a the average worker to lift or move. Steel rule is also sharp and must be handled with extreme caution. This project covers the basic terminology, the process, the HFE considerations, and the recommendations for handing cutting die. It is very important for any company using steel rule cutting die to consider the process. In the short term such considerations can improve efficiency and reduce waste in both process and motion in terms of lean manufacturing or improving the exiting process. In a long run it will reduce coworker injury and improve safety, which can reduce significantly in the cost of workplace injury and safety.

Reference

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