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Research Paper

DESIGN OF EXPERIMENTAL SETUP FOR PRODUCING STUD BOLT IN CIRCULAR ROLLING MACHINE

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Normally in circular rolling machine, the stud bolt is threaded in one side at a time. In order to improve the production cycle of circular rolling machine, we are going to redesign the existing die setup, in which simultaneously to make thread in both sides of stud bolt. The stud bolt to be manufactured has two varying shank diameter, which cannot be balanced while threading operation in normal machine setup. So this new experimental setup gives a balanced rolling operation and hence improves productivity of the machine in making stud bolt.

Keywords: Die setup, Circular rolling machine, Stud bolt, Productivity.

INTRODUCTION

Thread forming and thread rolling are processes for forming screw threads, with the former referring to creating internal threads and the latter external threads. In both of these processes threads are formed into a blank by pressing a shaped tool, commonly called a ‘thread rolling die’ against the blank, in a process similar to knurling. These processes are used for large production runs because typical production rates are around one piece per second. Forming and rolling produce no scarf and less material is required because the blank size starts smaller than a blank required for cutting threads; there is typically a 15 to 20% material savings in the blank, by weight. A rolled thread can often be easily recognized because the thread has a larger diameter than the blank rod from which it has been made; however, necks and undercuts can be cut or rolled onto blanks with threads that are not rolled. Also, the end of the screw usually looks a bit different from the end of a cut-thread screw.

Materials are limited to ductile materials because the threads are cold formed. However, this increases the thread’s yield strength, surface finish, hardness and wears resistance. Also, materials with good deformation characteristics are necessary for rolling; these materials include softer (more ductile) metals and exclude brittle materials, such as cast iron. Tolerances are typically ±0.001 in. (±0.025 mm), but tolerances as tight as ±0.0006 in (±0.015 mm) are achievable. Surface finishes range from 6 to

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32 micro-inches.

There are four main types of thread rolling, named after the configuration of the dies: flat dies, two-die cylindrical, three-die cylindrical, and planetary dies. The flat die system has two flat dies, the bottom one is held stationary and the other slides. The blank is placed on one end of the stationary die and then the moving die slides over the blank, which causes the blank to roll between the two dies forming the threads. Before the moving die reaches the end of its stroke the blank rolls off the stationary die in a finished form. The two-die cylindrical process is used to produce threads up to 6 in (150 mm) in diameter and 20 in (510 mm) in length. There are two types of three-die processes; the first has the three dies move radially out from the center to let the blank enter the dies and then closes and rotates to roll the threads. This type of process is commonly employed on turret lathes and screw machines. The second type takes the form of a self- opening die head. This type is more common than the former, but is limited by not being able form the last 1.5 to 2 threads against shoulders. Planetary dies are used to mass-produce threads up to 1 in (25 mm) in diameter.

Thread forming is performed using a flute less tap, or roll tap, which closely resembles a cutting tap without the flutes.

There are lobes periodically spaced around the tap that actually do the thread forming as the tap is advanced into a properly sized hole. Since the tap does not produce chips, there is no need to periodically back out the tap to clear away chips, which, in a cutting tap, can jam and break the tap. Thus thread forming is particularly suited to tapping blind holes, which are tougher to tap with a cutting tap due to the chip build-up in the hole. Note that the tap drill size differs from that used for a cutting tap and that an accurate hole size is required because a slightly undersized hole can break the tap. Proper lubrication is essential because of the frictional forces involved, therefore lubricating oil is used instead of cutting oil.

When considering the blank diameter tolerance, a change in blank diameter will affect the major diameter by an approximate ratio of 3 to 1. Production rates are usually three to five times faster than thread cutting.

PROPERTIES

Material Roll Ability

Successful thread rolling is a function of several application parameters. Among them is the type of thread to be rolled, its major diameter, pitch and root depth. Additional thread rolling considerations involve the ductility and cold- flow properties of the blank material. When a thread is rolled, the thread shape is imparted on the work piece blank by moving the parent material. A key parameter of this movement is the depth or root of the thread. As the roller displaces the material that will become the root, it flows out of the root both radially and axially.

The position of the rollers holds the thread pitch diameter to a predetermined size so the displaced material actually lengthens the work piece blank. Depending on the size and shape of the thread being rolled, material savings of 15 to 20 percent can be realized using thread rolling over turning or cutting. On a large production run, this can add up to a significant amount of stock. Because of the close relationship between the outside diameter of the thread and the work piece blank, it is critical that blank diameters be highly accurate. The material flow rate is calculated based on the specified blank diameter and variation. Either over or under this diameter will produce unacceptable threads. Undersized material will not fully flow into the roller dies and will cause undersized threads. Oversized blanks will exert undue pressure on the rollers and head resulting in potential damage to the thread rolling unit. Thread rolling success is determined in large part by the shape of the form to be produced. Most of the threads produced are made to the 60 degree Unified and similar standards, which are easily rolled. Most of the rollers used to produce these forms have relatively sharp crests, usually with radius edge to help the die penetrate the material. The angles of these threads, 30 degrees on each flank, provide the force to make the material flow axially and radially in a controlled and predictable manner. Acme and worm threads can be rolled, but the relatively large amount of material displacement and the distance the material must move can cause flaking on the flanks. Roll ability of these types of threads is improved by changing the thread's root configuration from flat bottom to a radius. Thread rolling can also be applied to burnishing, knurling and, in some cases, swaging operations.

Axial Thread Rolling

Depending on the type of machine and thread that needs to be manufactured, shops have several thread rolling configurations from which to choose. An axial thread roller moves from the tailstock end of the turning center, along the work piece blank centerline, to create a thread. General working ranges for axial heads are from 0.06 to 9 inches in diameter. The axial head is usually mounted in one of the turning center's turret tool pockets. In one pass, three (or up to six) rollers are fed onto the blank and activated by the rotation of the work piece blank. The arrangement of the rollers on an axial head allows the blank to pass through, which enables threads that are longer than the roller width to be formed. The first few threads on these heads are progressive, like a tap or broach, and require a chamfer on the work piece blank. Shorter progressions can be used for work up to shoulders or other work piece features, but roller life can be affected by the additional stress.

Tangential Thread Rolling

As the name implies, the tangential roller head makes its threads by approaching the work piece blank from the side. Sometimes called side rolling or cross slide heads, tangential thread roller are designed to roll threads by pushing, at a controlled feed rate, two fixed parallel rolls onto the rotating component. Mechanical or servo feed is required for tangential thread rolling. It is not possible to operate these rollers manually. The rolls make square, tangential contact with the work piece blank diameter forcing the material to plastically flow uniformly, taking the shape of the roller dies. This forming process is very fast and produces a precision profile, which is burr free.

In operation, the tangential roller will produce a complete thread in 15 to 30 revolutions of the work piece blank. An advantage of this thread roller type is it can form threads very close (within one thread or sometimes less) to either the front or back of a shoulder or other work piece feature. Tangential rollers only roll threads within the width of the rollers. Working width ranges for Fetter's tangential rolls are from 0.61 to 1.59 inches. These rollers are not recommended for Acme and trapezoid threads because force required is beyond the design limits of the holders

Radial Thread Rolling

A third type of thread roller is the radial head. It uses two or three rolls to form a thread in a single rotation of the work piece blank. The rolls on this type of thread roller are ground eccentrically. Starting with a flat on each roll, the thread form is progressive. A shallow thread form starts at one side of the flat and full form at the other side. A three roll radial head at rest uses the aligned flats to create a clearance opening. This allows the work piece blank to be positioned between the rolls and the finished threaded part to exit without damage to the threads. The two roll head uses the same principle. Internally, the rolls are set in motion by releasing tension springs attached to a rotating clutch. Once released, the rotation of the work piece or the roller unit continues the forward motion of the eccentric rolls until the torque of the work piece blank resets the clutch spring. The working range for the radial thread rolling head is 1/16 to 2 ½ inches in diameter. Like the tangential head, the thread length cannot exceed the width of the thread rollers.

Flexibility

Accurate and precise machining of threads is a key skill set for any shop. Considering thread rolling as a potential tool for the manufacture of threaded parts should be among a shop's processing strategies. Thread rolling requires a tooling investment to be made in the heads and rollers, which is higher than a single-point threading insert. However, for applications that involve hardened material, high surface finish and surface integrity as wells as production volumes, thread rolling technology may be more cost effective over the long haul. Moreover, since the heads can be run on a CNC turning center alongside single point threading, thread rolling can be flexibly applied as needed by the application-the right tool for the job.

COMPONENTS

Bearings

Roller bearings use cylinders of slightly greater length than diameter. Roller bearings typically have higher load capacity than ball bearings, but a lower capacity and higher friction under loads perpendicular to the primary supported direction. If the inner and outer races are misaligned, the bearing capacity often drops quickly compared to either a ball bearing or a spherical roller bearing.

Cylindrical Dies

Dies are used for threading the bolts. In this the inner dia of die is 80mm and the maximum dia of di9e size is 4inches. The maximum outer diameter of the die is 200mm.

Work Rest Blade

Figure 1: 2D Sketch of Work Rest Blade

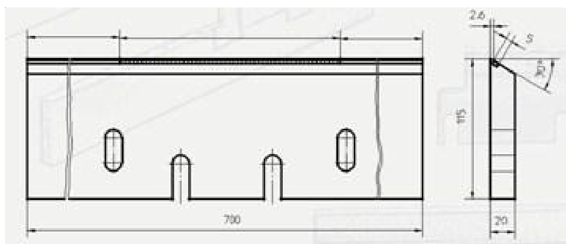
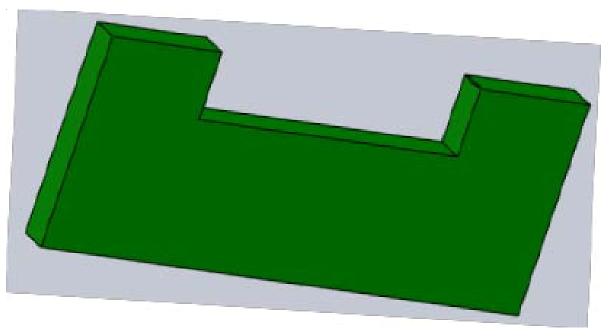


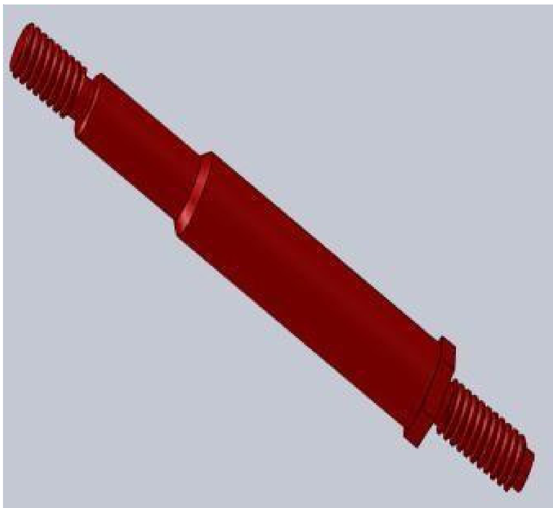
Figure 2: Work Rest Blade



It's mainly used for holding the work piece which prevent from slippage. The specification of work rest blade is shown below. Length =150mm, Height =80mm.

Stud Bolt

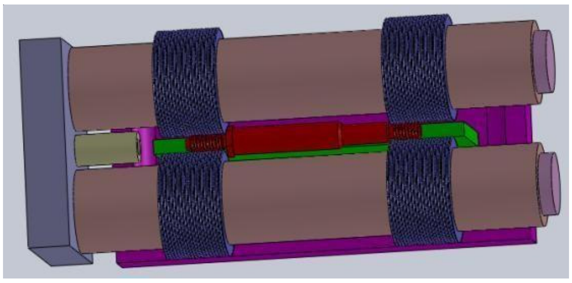
Figure 3: Stud Bolt



The stud bolt is a threaded rod with two heavy hexagon nuts. In the petroleum and chemical industry the fully threaded stud is the most common bolt used for flanged connections. The quantity of bolts for a flanged connection will be determined by the flange type and pressure class. Other type of stud bolts include double ends (threaded both ends only), tap ends (for threaded holes) and step downs (ends have different diameters). Stud bolts are available in all thread pitches diameters and metric sizes. Coatings and plating as well as plain finished oil and tempered is available as required by the end user. FSP has the capability to thread and manufacture specials from round bar to the customers drawings.

MODIFIED EXPERIMENT SETUP

Figure 4: Setup Above Rolling Machine



WORKING

Thread rolling is a commonly used manufacturing process for threading round work pieces,. It is by nature a forming process, thus no material is removed during threading of the blank. Production rates can be high, approaching 8pieces per second for smaller diameter parts, with slower cycle times for large diameter pieces. Multiple styles of machines are available, with the differences resulting from the types of dies and die motion used. The underlying process is the same for all machines; a blank is passed through moving dies, and the thread shaped dies progressively intrude on the work piece to be formed. Flat die rolling is common, especially in smaller diameter fasteners. In this process, the blank is rolled across the face of a stationary die with a reciprocating opposing die. In our modified setup, we are using four cylindrical dies. The die is in the form of circular threads; also it is fixed on the rotating shaft. When the work piece is placed on the work rest blade, it gets engaged with the rolling dies. At the same time work piece gets threaded.

By using this setup we have to increase the production of stud bolt and also increases the production cost and hence decreases the labor cost, manufacturing time, current charges.

Figure 5: Working Setup

MODEL CALCULATIONS

Height of work rest blade =80-(minor dia/2) Outer dia of the die can be calculated by using the formula

$D = d_2*N+(2/3)H$

Inner dia of die= 80mm

Die size = 2inches

Where,

N = number of starts of dies

H = height

Length of work rest blade = 150 mm.

Height of work rest blade = 80 mm.

Material for work rest blade = steel with carbide.

Shaft is subjected to a twisting moment only

$T/J = \tau/r$

$T = \tau/r * J$

J = polar moment of inertia

$J = \pi/32 * d^4$

Distance of natural axis to outer most fibre d/2

$P = 2\pi NT / 60$

$J = 4.0212* 10^6$

Where,

$\tau = 60$ N/mm^2 (from P.S.G design data book)

$T = 6.0318 * 10^6$ N-mm

Take , N = 250 rpm.

P = 157.9125 kw

Bending Moment

$M/I = \sigma_b/y$

y = d/2 = 40mm

$I = \pi/64 * d^4 = 2.011* 10^6$ mm^4

$\sigma_b = 100$ N/mm^2 (from P.S.G design data book)

$M = 5.0275 * 10^6$ N-mm

Verification

$$\frac{5.0275 * 10^6}{\pi/ 64 * d^4} = \frac{100}{d/^2}$$

$d^3 = 512.5969$

d = 80.003 mm

d = 80 mm

Hence it is safe.

BEARING CALCULATION

Life cycle of the bearing, L = 24000 hours.
Shaft speed = 250 rpm
Bearing reliability = 99%
Equivalent radial load = 1KN
Operating condition and material life adjustment factor = 0.9 &0.85
(from P.S.G design data book)
$(L_{99}/L_{90}) = (\log(1/R_{99})/\log(1/R_{90}))^{1/b}$(from P.S.G design data book)
$L_{99} = 60*N*L_h$
$L_{99} = 60*250*24000$
$L_{99} = 360*106$ rev

$(360*10^6/L_{90}) = (\log(1/0.99) / \log(1/0.9))^{1/1.17} * 0.9 * 0.85$

$(360*10^6/L_{90}) = (4.3648 * 10^{-3}/0.04576)^{0.8547} * 0.9 * 0.85$

$(360*10^6/L^{90}) = 0.1026648$

$L_{90} = 3.507 * 10_9$

$L_{90} = 3506.55 * 10^6$ rev

Dynamic load rating,

$C = W * (L_{90}/10^6)^{1/K}$

K = 3 for ball bearing.

$C = 1000 * (3506.55 * 10^6 / 10^6)^{1/3}$

C = 15.192 KN

Dynamic Load Rating = 15.192 KN.

CONCLUSION

Thus by implementing this experimental setup would increase the productivity of the circular rolling machine for manufacturing stud bolt.

REFERENCES

1. Alcombright, D S, and Bedwell, W T (1999), "Fastener Delivery System." *Proceedings of the Aerospace Automated Fastening Conference and Exposition*, pp. 125-128.
2. Anon (1987), "THREAD ROLLING." Manufacturing Engineering, Vol. 99(1), pp. 51-56.
3. Avella, S, and Mason, M T "Parts orienting by push- aligning." *Nagoya, Japan*, pp. 414-20.
4. Both well, J M (1989), "Automation - the 'real world'." *Fastener Age*, 3(5), 8.
5. Endres, T E (1998). "Fastener Feeding Systems." *1998 SAE Aerospace Automated Fastening Conference & Exposition Proceedings*, pp. 3-9.
6. Ginsberg, J H (1998), "Advanced Engineering Dynamics, Second Edition," *Cambridge University Press, NewYork*.