

# Design and Fabrication of Knurling Attachment tool in Corrugation Cutting Machine

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**Abstract:** The aim of our project is to design and fabricate a knurling operation tool that minimizes the cost of Knurling operation of Carton boxes which are manufactured in the company “Essential Packaging Pvt. Ltd.”. The company is manufacturing carton boxes in which they are seeking the help of external sources for knurling operation since they don't have a separate knurling machine. So, we decided to fabricate a knurling tool and attach it to the corrugation machine in the company in which the cardboard boxes can be knurled based on their requirement. Thus, the knurling tool can be used to perform the knurling operation in the corrugation machine itself. The knurling attachment consists of a knurling gear and roller fixed in a casing that is operated simultaneously using a motor. When the corrugated sheet is inserted between the gear and roller, the knurling operation is done on the sheet. The knurling attachment in the corrugation machine will reduce the cost of the knurling operation which is done separately in another firm. It eliminates the transportation cost of the cartons to the knurling firm. It also saves production time and increases the efficiency of the company.

**Key Words:** Knurling, Carton Box, Cost Reduction, Fabrication, Attachment.

## 1. INTRODUCTION:

In this challenging world, industries around the world constantly strive for lower-cost solutions for manufacturing their products. Our project is also based on targeting this parameter. Cardboard boxes are industrially prefabricated boxes that are primarily used for packaging goods, automobile parts, electronics, and other manufactured products. It can also be recycled easily. The corrugated board is the beginning of all corrugated packaging. A series of sophisticated machines acting in a unison to create the corrugated board is called a corrugator. The raw material of corrugated boards is containerboard grades of paper. A liner that becomes the flat facing of the board is primarily made from the long fibers of softwood trees. The medium which becomes the fluted middle layer of the corrugated board is made primarily from shorter fibers from hardwood trees. the journey of the carton box passes through several stages like “Design, Pulping The Pine Chips, Making Kraft Paper, Shipping And Storing The Kraft Paper, Corrugating The Cardboard, Fluting, Splicer, Double Glue Unit, Double Backer, Slitter Score, Cutoff Knife, Stacker, Converting Machines, Scrap, Scrubber, Flexo Machine, Folding The Boxes, Final Packing” and finally it comes to the “Quality Control” section before delivering it to the customer. We are going to fabricate a knurling attachment tool to perform knurling operations in the carton boxes.

## 2. OBJECTIVE OF THE PROJECT

- To determine a cost-effective method for performing a knurling operation.
- To eliminate the transportation cost of the company.
- To reduce the manufacturing time of the carton boxes.
- To utilize the factory workspace for installing knurling attachment setup.

## 3. MATERIALS:

### 3.1 List of components

S.NO	COMPONENT NAME
1	Base Frame
2	Knurling Tool
3	Supporting Roller
4	Shafts (2 no.)
5	Driving Gear
6	Meshing Gears (2 no.)
7	Screws (16 no.)

## 3.2 FUNCTIONS OF THE COMPONENTS

### 3.2.1 Base Frame

The base frame comprises three rectangular cross-sections made of iron having the following dimensions,

- Rectangular plate A - 400\*255\*25(mm)
- Rectangular plate B - 255\*255\*25(mm)
- Rectangular plate C - 255\*255\*25(mm)

### 3.2.2 Knurling Tool

The knurling tool is a spur gear setup made of cast iron having 26 teeth. We have used a spur gear of 90 mm diameter having 250 mm length. Spur gears are cylindrical gear, which is having parallel and coplanar shafts, and the teeth are straight and oriented parallel to the shafts.

### 3.2.3 Supporting Roller

The supporting roller supports the carton sheets which are pressed by the knurling gear when they are fed into the knurling tool. It is a cylindrical cross-section made of cast iron having a 90 mm diameter and 250 mm length. Roller support allows thermal expansion and contraction of the span and prevents damage to the carton.

### 3.2.4 Shaft

A shaft is a rotating machine element that is usually circular in cross-section. It is used to transmit power from one part of the machine to other parts of the machine the material used for ordinary shafts is mild steel. We have used a shaft of 20 mm diameter and 420 mm in length.

### 3.2.5 Driving Gear

The driving gear is used to transmit the power from the driving motor to the knurling tool. The driving gear has meshed with the gear coupled with the motor shaft. The knurling tool is mounted on the shaft which is coupled to the driving gear. The driving gear is 130 mm diameter having 34 teeth.

### 3.2.6 Meshing Gears

The meshing gears are used to transfer the power from the knurling tool to the supporting roller. Two spur gears are meshed together in which one gear is coupled with the knurling tool and other gear is coupled with the supporting roller. When power is transferred from the motor to the knurling tool through the driving gear, it makes the knurling gear to rotate. Since one of the meshing gear is coupled with the knurling gear shaft it makes the other meshed gear to rotate. Hence the supporting roller is also rotated.

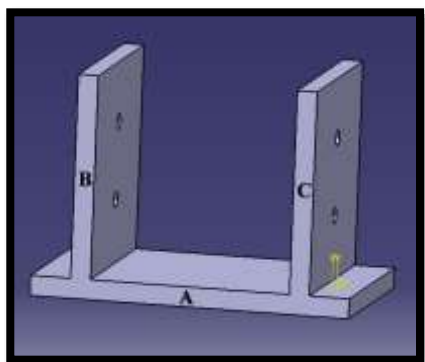


Fig 3.1: Base Frame

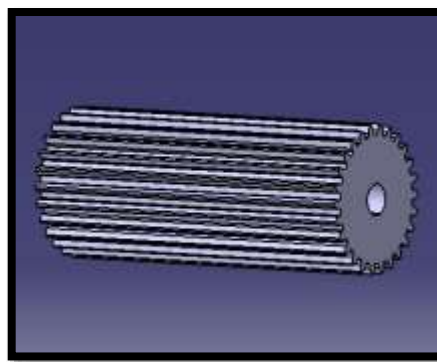


Fig 3.2: Knurling Tool

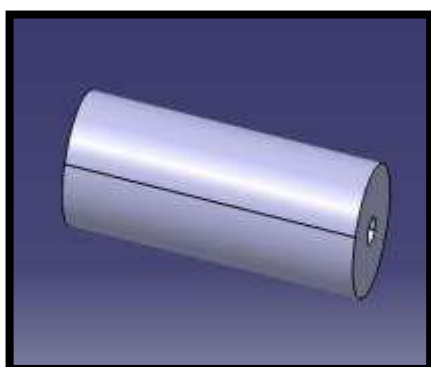


Fig 3.3: Supporting Roller

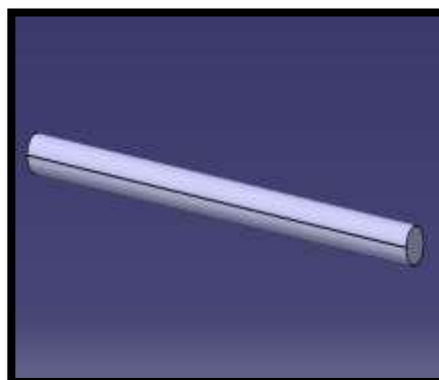


Fig 3.4: Shaft

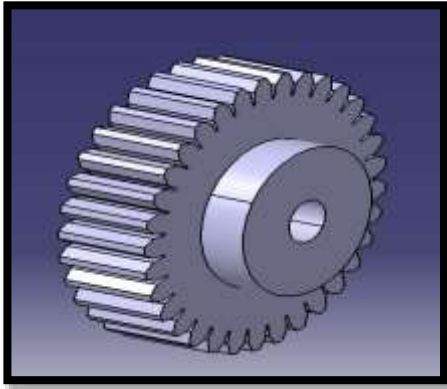


Fig 3.5: Driving Gear

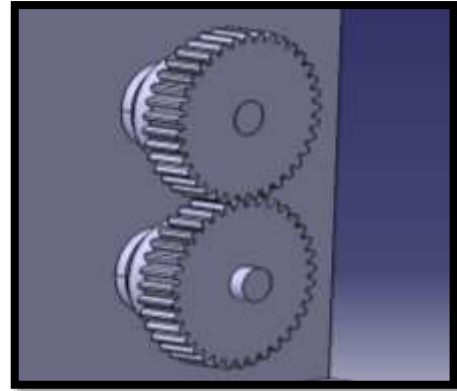


Fig 3.6: Meshing Gears

#### 4. DESIGN OF EXPERIMENT (DOE)

We have created the experimental design of the knurling attachment tool in a 3-Dimensional designing software CATIA V5.

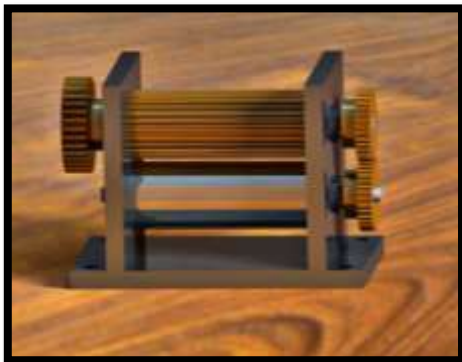


Fig 4.1: Rendered Image of Knurling Tool

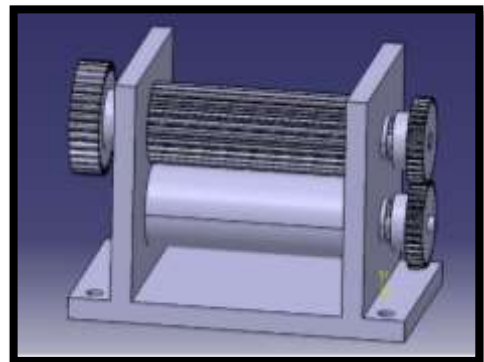


Fig 4.2: 3-Dimensional Image of Knurling Tool

#### 5. METHOD:

##### 5.1 The Corrugation Cutting Machine

The carton boxes start their process in the corrugation cutting machine. Here the raw material in the form of Kraft reel is fed into the corrugation cutting machine. Two Kraft reels are loaded into the machine where one sheet is fed into the fluting roller and another sheet forms the base of the corrugated sheet. The fluting roller presses the incoming sheet and creates a fluted structure. Glue is applied on the tip of the flutes by a glue roll. Then a pressure roller joins the glued flute and the base sheet which forms a corrugated sheet. The corrugated sheet is cut into the required sizes by a board cutter. The corrugated boards are arranged and sent for the next operation.



Fig 5.1: The Corrugation Cutting Machine

## 5.2 Knurling Attachment Tool

We have designed and fabricated a knurling tool to perform the knurling operation on the corrugated sheets. The tool consists of a base frame, a knurling gear, a supporting roller, two shafts for knurling gear and supporting roller, driving gear, and two meshing gears.



Fig 5.2: knurling tool



Fig 5.3: Corrugated board fed into the knurling tool

When the corrugated boards are fed into the knurling tool the knurling gear presses the boards against the roller and as a result knurling impressions are formed on the corrugated boards. Fig 5.2 shows the image of the knurling tool and Fig 5.3 shows the image of the knurling tool with corrugated board fed into it for knurling operation.

## 6. RESULTS AND DISCUSSIONS:

### 6.1 OUTPUT OF KNURLING TOOL

The company has the current project of 248\*1300 mm corrugated board and we have designed a tool accordingly. The images of the knurled corrugated boards are given below



Fig 6.1: Before and after Knurling operation

Fig 6.1 shows two images of corrugated boards. Before knurling operation, the board looks plain. When the board is fed into the knurling tool, we can find the knurled impressions on the output corrugated board. Now the company can use the knurled corrugated boards for further process for manufacturing carton boxes.

### 6.2 PRODUCTION RATE

Based on our observation we found that the production rate of the knurling attachment tool is 30 boards per minute. We did three sets of observation and we calculated the mean production rate of 30 boards per minute. The production rate may slightly vary depending upon the thickness and length of the corrugated sheet.

### 6.3 COST REDUCTION

Since the company doesn't have a separate knurling machine they are getting the help of another similar industry for performing the knurling operation. By using the knurling attachment tool only one-third of the total cost is spent on knurling operation. Thus by using the knurling attachment tool the company reduces the production cost of the carton boxes.

## 7. CONCLUSION:

The knurling attachment that we have fabricated can be used to knurl the corrugated sheets of dimensions 248\*1300 mm. The cost of the knurling operation of the corrugation boxes in another industry can be eliminated by using the knurling attachment tool. The motor which is used to run the corrugation cutting machine also drives the knurling attachment tool with the help of driving gears. Thus the cost of electricity can also be reduced. Different size corrugated sheets can be knurled in this knurling attachment tool. We have met the requirements of the company by reducing production costs. This tool helps in reducing the transportation cost of the company. We have utilized the factory workspace for installing the knurling attachment setup.

We have designed and fabricated a knurling operation tool that minimizes the cost of Knurling operation of Carton boxes which are manufactured in the company. Thus by using this knurling attachment tool, the company does not have to buy a separate knurling machine. The company has reported that by using our knurling attachment tool they are spending only one-third of the previous production cost. The corrugated sheets that are knurled using the knurling attachment tool have passed the quality inspection in the company and have met the requirements of the customer.

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