

Design and Manufacturing of Automated Card sheet Cutting Machine

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Abstract - At present card sheet Cutting machines used industries are very heavy, consumes lot of power and are difficult to use. So different design which uses rotary mechanism. Due to the rotary mechanism continuous operation and also increases in the speed of operation is ensured. This project also aiming to make operation automatic by using Arduino to control feeding mechanism. Mathematical modelling has been done for checking machine for different stresses and finding out optimum dimensions. Furthermore, machine components were tested on ANSYS software to find deformation in actual workloads.

Key Words: Roller, DNS Test, Laser Cutting

1. INTRODUCTION

The Automated card sheet cutting Machine system is a combination of electronic mechanical parts. Input Devices are devices used to gather information about the system, which consists switches (toggle switch) and sensors, in order to feed the controller (Arduino) by an information about the belts status and objects to be carried. The controller, which is the main element that operate the whole system, uses the information from the sensors which takes the counting and movement decision prior to sending the orders to the output devices by the actuators and the relays. Output Devices are the actuators that converts an electrical signal into mechanical movement

1.1 Methodology

The main purpose of this model is to reduce cost and time of cutting operation. Conveyor for transmission of sheet is used. Here the cutting assembly will cut cardboard sheet at a point and due to pressure applied by rollers the sheet will cut automatically in that direction. To transfer power gear drive with pulley is used. Our main aim while manufacturing is to reduce frictional losses and maintain the speed of motor to maintain proper friction in between roller and the paper. Also, the paper should pass without slipping for the proper cutting. The overall cost of project is to be minimized by using complementary materials then actual heavy industrial material.

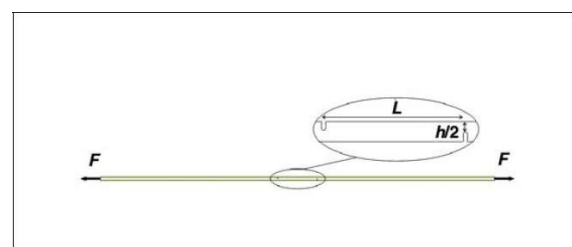
DNS Test

The DNS test is very simple method for production control. The sample preparation procedure is:

-Cutting two notches on a paperboard sheet, one from each side of the specimen separated by a distance L . The cut was made by a razor blade to half the paperboard thickness $h/2$. Prior to cutting, the paperboard was placed on a movable $x-y$ table, and the razor blade was fastened onto a movable stage. Hence, very precise notches could be made.

-Cut 15 mm wide notched specimens from the paperboard sheet; comparable to the method for in-plane tensile testing. The maximum stress measured was used to calculate the maximum shear stress in the specimen.

The double notches generate stress concentrations that result in quite uniform strain fields. The double grooves produce a stress concentration resulting in a fairly uniform strain field. It can be concluded that, for the typical elastic properties of paper materials, the shear stress distribution is quite uniform. In addition, Whitney's analysis shows that the shear stress distribution is related to the length of the shear zone, L . As L decreases, the shear stress distribution becomes more uniform, for the parameters, resulting in a rather flat stress profile. Therefore, the notch effect is small. In addition, due to the structure of the fiber network, cardboard is less prone to cracking in thickness than homogeneous materials. Maximum shear stress insensitive to cracks in the MD-CD plane.



1.2 Components

Arduino- It is an open-source proto type based on easy-to-use hardware and software. It consists of a circuit board and can be programmed and software called Arduino IDE can be used to write and upload the computer code to the physical board.

Motor- Motor selected is AC Single Phase Induction motor. We use the single-phase power system more widely than three phase system for commercial purposes, domestic

purposes, and in industrial uses. Since the single-phase system is more economical than a three-phase system, single-phase system is used. The single-phase motors are simple in construction, cheap in cost, reliable and easy to repair and maintain.

Roller- Roller for the setup is selected to apply pressure on die cutter to easily cut the paper. The rollers are made of mild steel. The paper is fed between the two rollers, the upper roller has die mounted on it.

Belt and Pulley- Type A V- belt pulley is used to transmit the power between the axel using v belt which is mechanical linkage with trapezoidal cross section. The combination of these devices provides a high-speed power transmission solution that is resistant to slippage and misalignment. The V-belt is a unique mechanical connection with a cross section similar to an isosceles trapezoid. The V-belt and its complementary pulleys form the most efficient belt drive known (sometimes achieving 98% transmission efficiency).

Die - The die is a pre-shaping tool that works in conjunction with the press to manipulate the material to the desired size and shape. The press pushes the material (plastic, metal, or composite) into the cavity of the die, creating a new object of the same size and shape as the die. The die for the current machine is made out of plywood on which the slots of less than 1 mm are cut by laser.

Bearings - Bearings support and guide rotating or vibrating mechanical elements (shafts, axles, wheels, etc.) and transfer loads between mechanical components. They provide high precision and low friction, enabling high speeds while reducing noise, heat, energy consumption and wear. Bearings are inexpensive, replaceable mechanical elements that typically comply with national or international dimensional standards.

Conveyor Belt-Conveyor systems are used to systematically move and transport materials commonly used in industrial environments. Conveyor belts have been tested and are a real energy saver for efficiency. The conveyor belt works very easily and two electric pulleys move durable materials over long distances. When the motor in the pulley rotates at the same speed and in the same direction, the belt moves between the two. Belt and conveyor system is used here to handle and feed paper to the machine at right instance and at right time to accommodate smooth punching operation. Conveyor would be of around 250 mm in length and width so that it can handle big size box paper too.

Component	Material
Frame	MS Sq. Tube
Shaft	MS Bar
Roller Disc	MS Plate
Die	Wooden Sheet
Bearing	Ball Bearing
Screw	EN 8
Bridge	Aluminum Square/Rectangular Tube
Cutter	Steel

Table -1: Components

2. Manufacturing

Laser Cutting- Laser cutting is primarily a thermal process that uses a focused laser beam to melt material in a local area. A coaxial gas jet is used to drain the molten material and create a cut. Continuous cuts are created by a laser beam or CNC controlled movement of the workpiece. There are three main types of lasers cutting. Fusion cutting, flame cutting, and remote cutting.

Fusion cutting uses an inert gas (usually nitrogen) to drain the molten material through the cut. Nitrogen gas does not contribute to energy input because it does not undergo an exothermic reaction with the molten material.

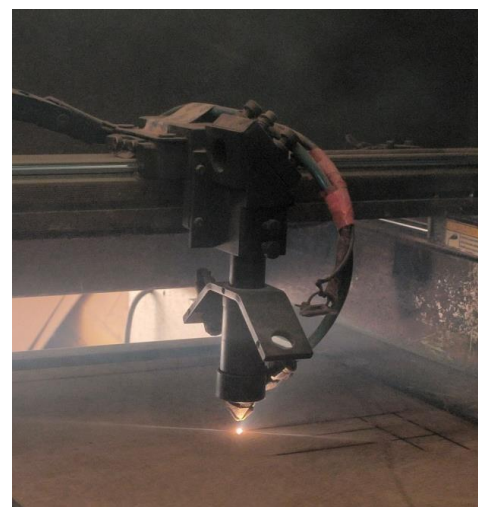


Fig -1: Laser Cutting

Turning- Turning is a form of machining, a material removal process used to cut out unwanted material to create rotating parts. Lathe processing requires a lathe or lathe, workpieces, fixtures, and cutting tools. Workpieces are preformed materials that are mounted on a fixture and then on a lathe to allow them to rotate at high speeds. Cutting tools are usually single-point cutting tools attached to the machine,

but some operations use multi-point tools. The cutting tool enters a rotating workpiece and cuts the material in the form of small chips to create the desired shape.

Milling (Keyway)-Keyway milling machine is the process of making keyways with a milling machine. A key refers to the type of part used for mechanical transmission, primarily to secure the shaft and parts on the shaft in the circumferential direction and transmit torque. When the pulley is attached to the shaft, the keyway prevents the pulley from rotating on the shaft. Keyways are divided into open type, semi-open type, and closed type. The keyway is done on the shaft to mount the pulley hence to rotate the roller at desired speeds with the help of motor.

Welding- Arc welding is a type of welding process that uses arcs to generate heat to melt and join metals.

The power supply uses either direct current (DC) or alternating current (AC) to generate an arc between the consumable or non-consumable electrode and the base metal. The arc can be guided manually or mechanically along the joint line, but the electrodes either simply carry an electric current or at the same time melt into the weld pool, introducing the filler material to the joining area.

Welding is widely used for making frames, connecting square metal pipes to roller sheaves, and connecting shafts to sheaves. The machine used for welding is an arc welding machine.

Cutting- Vertical cutters are power tools designed to make accurate square and angled cuts in wood. It works by rotating a steel circular saw blade at high speed. When you push down on the handle, the blade cuts through the steel placed on the support table. The machine was used to cut all the plates in desired size.

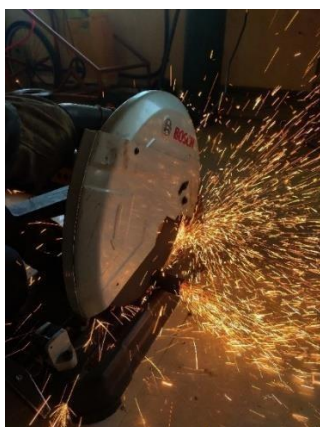


Fig -2: Vertical Cutting

Grinding- We used angle grinder for polishing the surfaces and also to cut unconventional slots in plate. An angle grinder is a mechanically driven hand tool with a rotating grindstone. The disc is mounted at right angles to the motor and rotates at very high speeds.

3. FEA Analysis

We perform an analysis of components such as rollers, shafts and frames in Ansys software. To check the frame and roller resistance and to check the shaft torsion, we apply the calculated load and torque on the roller and shaft.

Mesh size selection-

The mesh size is calculated by checking the independence of the meshes. When the roller static analysis with force value 1000 N is done for different mesh sizes from 25 mm to 1mm and we get the best mesh results at 20 mm, mesh size and histogram are variable mesh shape and size, when the strain remains constant. This means that there will be negligible changes in the accuracy of the results when further reducing the mesh size.

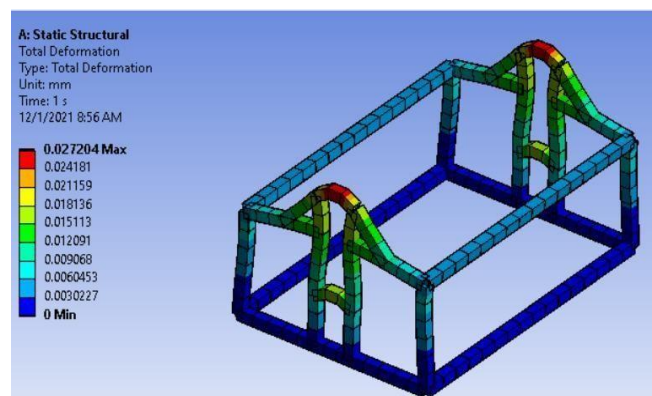


Fig -3: Total deformation on frame

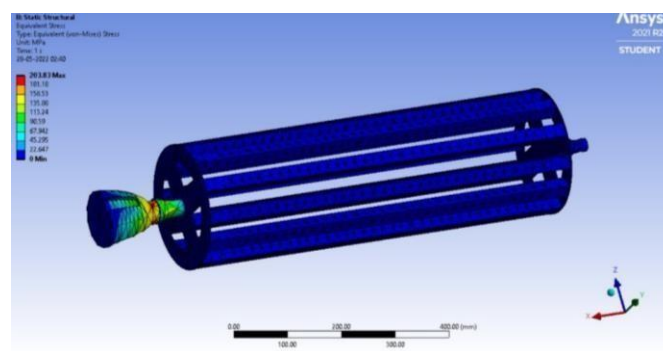


Fig -4: Equivalent stress on shaft

4. Result

Nature of cut is pretty clear on card sheet but with different types of card sheet paper, efficiency of the cut

varies. for instance, for paper to be cut efficiency was about 95 percentage whereas for E flute it was 85 percentage.

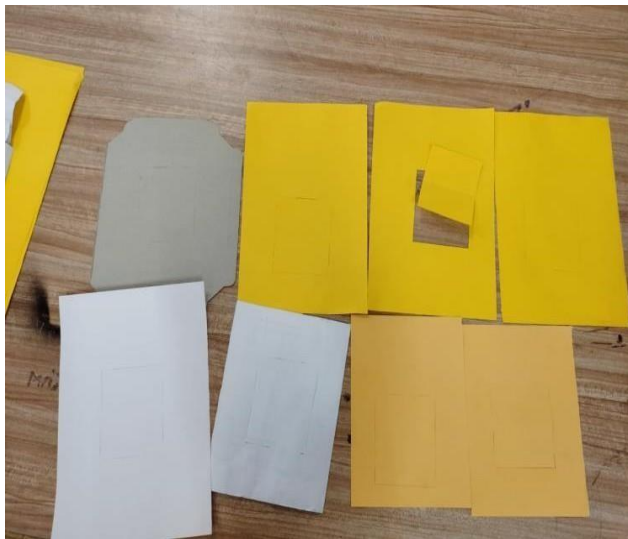


Fig -5: Testing on different paper

Mesh Size	20 mm
Nodes	60872
Elements	30409
Moment Acting	30 N.m
Total Deformation	0.135 mm
Equipment Stress	203.18 MPa
F.O.S.	2.21

Table -2: Ansys result of shaft

Papersheet	Thickness (in mm)	Cutting efficiency
Paper	0.2	95%
Kraftpaper	0.22	95%
Cardsheet	0.35	95%
E-flute	1.6	85%

Table -3: Testing on different paper

5. Future Scope

- In addition, due to automatic feeding it will reduce idle time and decrease machine cycle time henceforth reducing working hours at the end of day.
- The machine will be user friendly and hence can be used by low-skilled worker.
- Eliminate drive train inefficiencies.

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