# DESIGN & FABRICATION OF MANUAL ROLLER MACHINE.

A thesis report submitted to the department of mechanical engineering for the partial fulfillment of the degree of Bachelor of Science in Mechanical Engineering.

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# APPROVAL

This is to certify that the project on **"Design & Construction of Manual Roller Bending Machine."**By **Sagir Ahammed** (ID No: ME 2103025333), **Md. Mamun Hossain** (ID No: ME 2103025334), **Md. Mahabul Hossain** (ID No: ME 2103025504), **Ifran Ibney kashim** (ID No: ME 2103025434), **Md. Fayeas Anam Shafin** (ID No: ME 2103025505) has been carried out under our supervision. The project has been carried out in partial fulfillment of the requirements of the degree of Bachelor of Science (B.Sc.) in Mechanical Engineering of years of 2025 and has been approved as to its style and contents.

**……..**
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# DECLERATION

We, hereby, declare that the work presented in this project is the outcome of the investigation and research work performed by us under the supervision of Md. Minhaz Uddin, Assistant Professor Department of Mechanical Engineering, Sonargaon University (SU). We also declare that no part of this project and thesis has been or is being submitted elsewhere for the award of any degree.

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# ABSTRACT

The **"manual roller bending machine"** is a simple yet efficient mechanical device designed to bend metal sheets and rods into desired curves or cylindrical shapes without the use of automated systems. This project aims to develop a low-cost and user-friendly machine suitable for small-scale workshops and educational institutions. The machine operates manually using hand-driven rollers, which apply uniform pressure to deform the metal work-piece gradually. The design focuses on portability, ease of use, and structural integrity while minimizing fabrication costs. During the development phase, different materials and mechanical components were selected based on strength and performance criteria. The successful fabrication and testing of the machine demonstrate its capability to perform precise bending operations for various thicknesses of metal sheets. This project contributes to the field of mechanical manufacturing by providing a practical solution for bending tasks where automation is not feasible or economical.

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# Chapter 01 Introduction

## 1.1 Background of the Study

Bending is a common process in metalworking used to create curved shapes from flat sheets or rods. Most available machines for this purpose are expensive and need electricity. In small workshops or rural areas, a simple, low-cost, manual bending solution is more practical. This project focuses on developing such a machine using basic mechanical principles.

## 1.2 Problem Statement

Modern bending machines are not affordable or usable in all environments, especially where electricity or skilled labor is limited. Hence, there is a need for a manual bending machine that is easy to operate and build.

## 1.3 Objectives of the Project

- To design a simple manual roller bending machine.
- To bend metal sheets or rods without using electrical power.
- To test the machine's performance for light-duty work.

## 1.4 Scope of the Project

The machine will be suitable for small-scale bending of metal sheets or rods. It is intended for use in workshops, vocational training centers, and rural industries. The project includes design, fabrication, and performance testing.

## 1.5 Organization of the Report

This thesis is divided into chapters covering literature review, methodology, design, fabrication, working principle, results, and conclusions.

# Chapter 02 Literature Review

## 2.1 Previous Research

In previous studies, several low-cost bending machines were developed for educational and workshop use. Most of them were manually operated and designed for thin metal sheets. Researchers focused on simplicity and affordability. However, many earlier projects lacked detailed analysis on material strength, roller design, and safety considerations. These research works laid the foundation for further improvement.

## 2.2 Existing Machines

Currently available bending machines can be categorized into three types: manual, hydraulic, and CNC. Manual machines are simple but limited in capacity. Hydraulic machines provide more power and are used in industries but are expensive. CNC machines are fully automated and offer high precision, but their cost and complexity make them unsuitable for small-scale users.

## 2.3 Gaps in Current Technology

There is a noticeable gap between high-cost industrial machines and low-cost manual machines. Most manual machines are not designed for bending thicker materials or maintaining consistent accuracy. Adjustable roller spacing, strong frame design, and ease of operation are also missing in many models. This project attempts to fill these gaps by designing a better manual bending machine that is affordable, efficient, and user-friendly.

# Chapter 03 Methodology

## 3.1 Project Planning

The project was planned in several stages: concept development, design drafting, material selection, fabrication, and testing. A simple Gantt chart was prepared to track the progress of each phase within the semester timeline.

## 3.2 Design Approach

The machine was designed using basic mechanical principles. The structure includes three rollers, a frame, a handle, and a gear mechanism. The middle roller is adjustable to apply pressure and form the bend. The design was first sketched manually and then finalized using CAD software.

**Design of Manual Roller Bending Machine :**

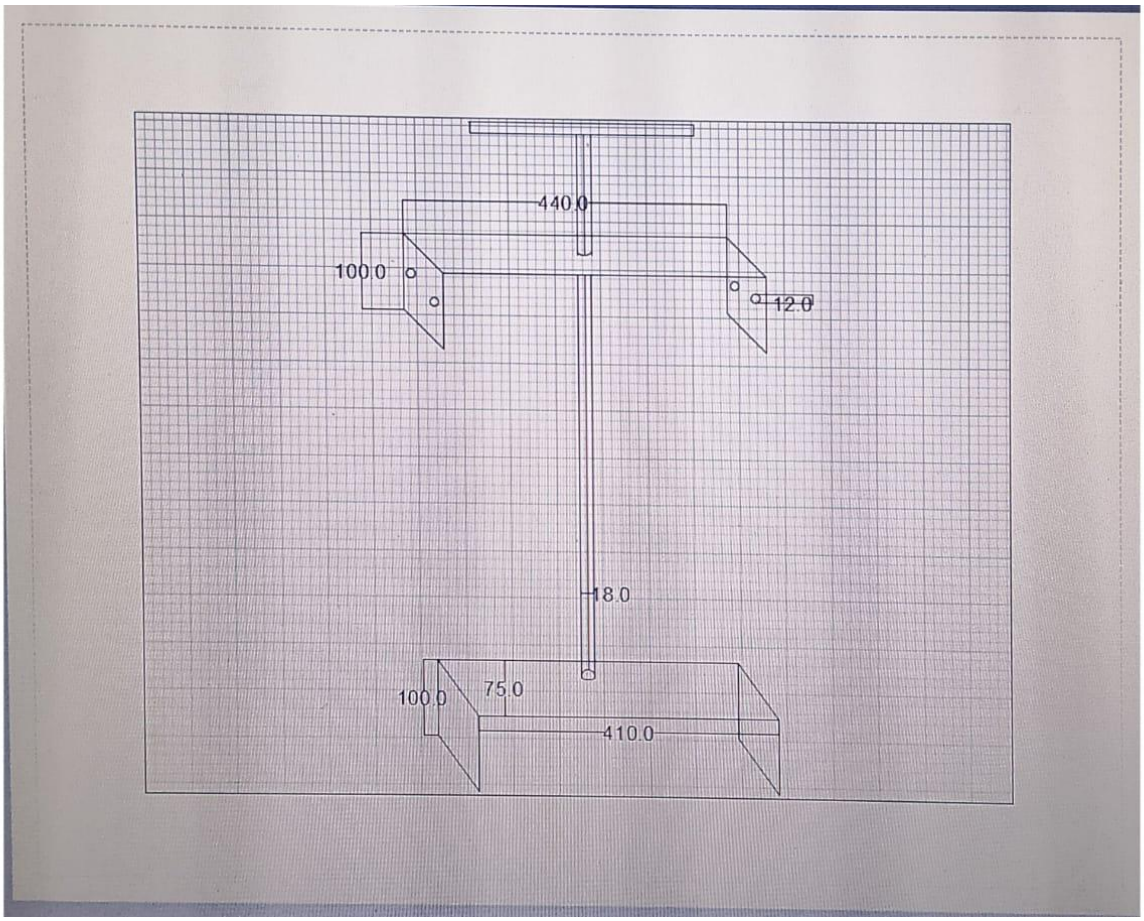



**Figure: Design of Supporting Frame**

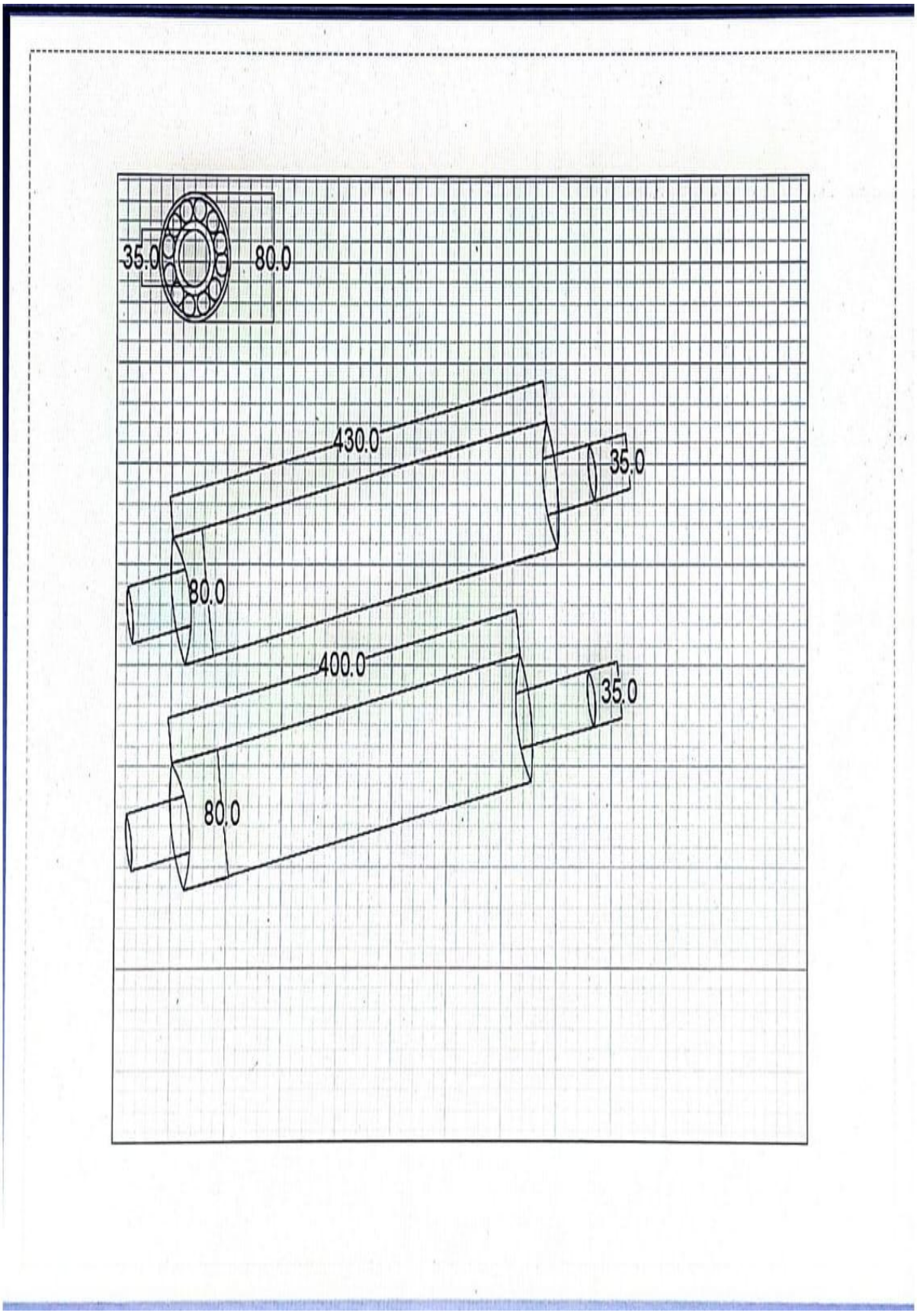



**Figure: Diagram of MS Roller**

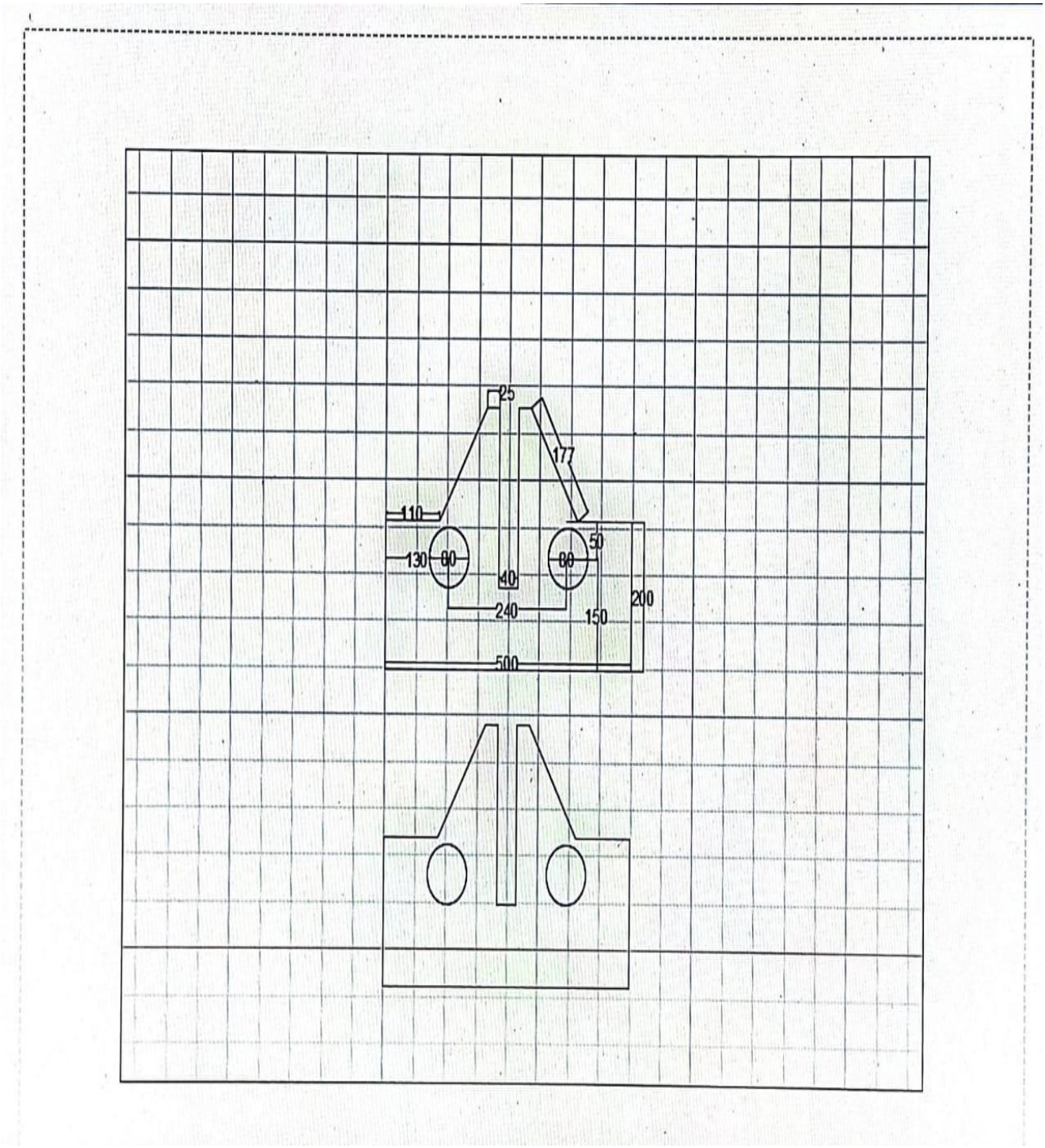



**Figure: Supporting Plate**

### 3.3 Material Selection

- Materials were chosen based on strength, availability, and cost:
- Frame: Mild steel (for rigidity and weld ability)
- Rollers: Hardened steel (for durability)
- Handle: Hollow steel rod (for easy rotation)
- Bearings and shafts: Standard-sized industrial components

### 3.4 Tools and Equipment Used

- The following tools were used during fabrication:
- Gas welding machine
- Angle grinder
- Drill machine
- Measuring tools (scale, caliper, square)
- Bench vice and clamps

### 3.5 Required Instruments:

- SKF Ball Bearing
- Free-wheel Gear
- MS Chain
- MS Roller
- SS Nut-Bolt
- MS Plate

### 3.5.1 SKF Ball Bearing:



**Figure: Bearing**

**SKF Ball Bearing – Working Principle:**

"SKF (Sensual Kullagerfabriken) is a leading manufacturer of ball bearings. Though "SKF" is a brand, the working principle of an SKF ball bearing is the same as any standard ball bearing.

Basic Working Principle of a Ball Bearing

A ball bearing reduces rotational friction and supports radial and axial loads using balls positioned between two races:

Main Components:

1. Inner Ring – Attached to the rotating shaft.
2. Outer Ring – Fixed in the housing.
3. Balls – Roll between the rings, carrying the load.
4. Cage (Retainer) – Keeps the balls evenly spaced.
5. Seals/Shields (optional) – Protect the bearing from contaminants.

Application:

1. Load Application:

- When a load is applied to the bearing, it is transferred from the outer ring to the balls.
- The balls then transfer this load to the inner ring, allowing smooth rotation.

2. Rolling Motion:

- plain bearings. AS the inner ring rotates with the shaft, the balls roll rather than slide.
- Rolling motion significantly reduces friction compared to

3. Friction Reduction:

- Point contact between the balls and races minimizes surface area in contact, reducing friction and wear.
- This allows for high-speed and low-torque operation.

4. Load Types:

- Radial Load: Perpendicular to the shaft (most common).
- Axial Load (Thrust Load): Parallel to the shaft.
- Some ball bearings (like angular contact or thrust bearings) are designed to handle a combination of both.

Example: SKF Deep Groove Ball Bearing

- Most common type.
- Can handle radial and limited axial loads.
- Often used in motors, pumps, fans, and gearboxes.

 Advantages of SKF Ball Bearings:

- High precision manufacturing ensures long life and low vibration.
- SKF's special coatings, lubricants, and materials enhance corrosion resistance, load capacity, and temperature tolerance.

Summary

| **Feature** | **Description** |
|---|---|
| Motion Type | Rolling |
| Load Transfer Path | Outer ring → balls → inner ring |
| Friction | Very low due to point contact |
| Types of Load | Radial (main), axial (limited in some types) |
| Common Applications | Motors, wheels, pumps, conveyors, machinery |

### 3.5.2 Free-wheel Gear:




**Figure: Free-Wheel Gear**

**<u>Working Principle of a Freewheel Gear (Freewheel Mechanism):</u>**

"A freewheel gear (also called a Freewheel, overrunning clutch, or ratchet mechanism) is a mechanical device that allows a shaft to rotate freely in one direction but locks and transmits torque in the other.

Main Components:

- Driving Gear or Hub – Connected to the input (e.g., pedals).
- Driven Gear or Outer Shell – Connected to the output (e.g., wheel).
- Rollers, Pawls, or Sprags – Internal locking mechanism that engages or disengages rotation based on direction.
- Retaining Spring – Helps pawls or rollers reset.

Forward Rotation (Drive Engaged) :

- When you rotate in the driving direction, the pawls or rollers lock into the notches or ramps of the outer gear.

- ❖ This locks the inner and outer gears together, transmitting torque.
- ❖ In a bicycle, pedaling forward drives the wheel.

**Summary Table:**

| **Feature** | **Description** |
|---|---|
| Motion Allowed | One direction only (driveshaft → output) |
| Opposite Direction | Output free to rotate (input idle) |
| Common Mechanisms | Pawls, rollers, sprags |
| Key Benefit | Prevents backward force on the driver |
| Example | Bicycle rear hub, car starter motor, ratchet tool |

### 3.5.3 MS Chain



**Figure: MS Chain**

**<u>Working Principle of MS Chain (Mild Steel Chain):</u>**

An MS Chain refers to a Mild Steel Chain, commonly used in mechanical power transmission, lifting, material handling, or conveying systems.

Basic Working Principle

An MS chain works by transmitting mechanical force via linked segments (chain links) that engage with sprockets or pulleys. It transfers pulling force (tension) between two or more components in a system.

**1. Force Transfer via Links:**

- As the sprocket turns, it pulls the chain forward.
- The chain links transmit this motion to the next component (e.g., another sprocket or load).

**2.** Load Movement**:**

- The second sprocket or attached load (like a conveyor or pulley system) moves with the chain.
- Tension in the chain allows power to be transmitted over a distance.

**Key Components**:

- Chain Links: Made from mild steel, offering strength and ductility.
- Sprockets: Toothed wheels that guide and drive the chain.
- Connecting Pins: Join the links and allow pivoting motion.
- Rollers (if present): Reduce friction between chain and sprocket.

**Applications of MS Chains:**

| **Application Area** | **Function** |
|---|---|
| Conveyor Systems | Move goods/materials along a track |
| Bicycles/Motorbikes | Transfer rotational motion from pedals or engine |
| Lifting Mechanisms | Hoist or pull loads via pulleys or drums |
| Agricultural Equipment | Drive power to moving parts (e.g., tillers) |

### 3.5.3 MS Roller



**Figure: MS Roller**

Working Principle of an MS Roller (Mild Steel Roller):

"An MS Roller (Mild Steel Roller) is a cylindrical mechanical component made from mild steel, used in conveyors, rolling machines, bending machines, and material handling systems. It rotates to move or shape materials through contact, friction, or pressure.

 Basic Working Principle

An MS roller works by rotating along its axis to either:

- Transport a material (like in conveyors), or
- Deform a material (like in sheet metal bending machines).

The working principle depends on the type of roller application, but the core idea is rotational motion creating friction or force on a surface or object.

Types of MS Roller Applications & Their Working Principles:

- Conveyor Roller

Purpose: Move materials along a path.

Working Principle:

- Rollers are mounted on shafts and rotate freely (or are motor-driven).
- As the roller turns, friction between the roller surface and the object causes the object to move.
- Used in belt conveyors, gravity conveyors, or powered rollers.

2. Bending Roller (Sheet Metal Roller)

Purpose: Bend flat sheet metal into curves or cylinders.

Working Principle:

- Sheet metal is passed between two or more MS rollers.
- The top roller applies downward pressure, forcing the metal to conform to the shape of the rollers.
- Rotating the rollers pulls the sheet through and applies consistent pressure to create a curved shape.

3. Press or Forming Roller

Purpose: Apply pressure to shape or compress materials (e.g., in rolling mills).

Working Principle:

- MS rollers rotate and apply high force/pressure on the material.
- This compresses or shapes the material while it's in motion.
- Used in steel mills, textile mills, and rubber processing.

**Summary Table:**

| **Feature** | **Description** |
|---|---|
| Motion Type | Rotational |
| Material | Mild Steel (low carbon, ductile, affordable) |
| Power Source | Manual or motor-driven |
| Function | Transport, bend, or press material |
| Common Applications | Conveyors, rolling machines, sheet metal bending, mills |

### 3.5.4 SS Nut-Bolt



**Figure: SS Nut-Bolt with Washer**

**Working Principle of SS Nut and Bolt:**

"An SS Nut and Bolt refers to a fastening system made from stainless steel (SS). This system is used to join or secure two or more objects together by creating a tight and secure connection through threaded engagement between the bolt and nut.

Components of SS Nut and Bolt:

Bolt:

- A metal rod with threads (typically external threads) that runs along its length.
- The head of the bolt allows it to be turned with a tool (like a wrench or screwdriver).

1. Nut:

- A hexagonal or square piece with internal threads.
- It engages with the external threads of the bolt to create a secure connection.

2. Washer (optional):

- A flat ring that is often used to distribute the load over a larger surface area and prevent damage to the material being fastened.

Working Procedure:

1. Bolt Insertion:

- The bolt is inserted through the materials to be fastened (e.g., a metal sheet or two structural components).
- The threaded end of the bolt extends through the hole, and the nut is placed over the exposed end.

2. Thread Engagement:

- The external threads of the bolt engage with the internal threads of the nut when the nut is turned in a clockwise direction.
- This creates a mechanical grip, pulling the nut and bolt together.

3. Tightening:

- A wrench or spanner is used to tighten the nut on the bolt.
- As the nut turns, it moves along the bolt's threads, pulling the two materials tighter together.
- Friction between the threads helps maintain a secure and stable connection.

4. Load Transmission:

- The tightened bolt and nut system provides a clamping force that holds the materials together and transmits load across the joint.
- This clamping force resists shear and tensile forces acting on the materials, preventing them from separating.

5. Prevention of Loosening:

- The friction between the bolt and nut threads keeps the joint secure.
- Lock washers, thread adhesives, or nylon inserts in the nut can further prevent loosening due to vibration or dynamic loads.

**Summary Table:**

| Feature | Description |
|---|---|
| Material | Stainless Steel (SS), highly resistant to corrosion |
| Threads | Internal (nut) and external (bolt) threads |
| Function | Join components by creating a tight, secure connection |
| Application | Used in construction, machinery, automotive, etc. |
| Advantage | Corrosion resistance, high strength, aesthetic appeal |

### 3.5.5 MS Plate



**Figure: MS Plate**

## Working Principle of MS Plate (Mild Steel Plate):

“An MS plate (Mild Steel Plate) is a flat-rolled sheet of low-carbon steel used in construction, fabrication, machinery, and structural applications. While a plate itself is not a machine with a "working principle", it functions as a structural and load-bearing element based on material and mechanical principles.

Key Concept: Functional Principle of an MS Plate

The working principle of an MS plate lies in how it behaves under different loads and in structural applications, such as:

- Carrying weight
- Withstanding forces
- Distributing loads evenly

 Engineering Working Principles Behind MS Plate Use

1. Load Distribution

- MS plates distribute applied loads over a surface area.
- In floors, walls, or support structures, they spread the force to avoid stress concentration.

2. Flexural Strength (Bending Resistance)

- MS plates resist bending when a load is applied.
- Thickness and steel grade determine how much a plate can resist deformation.

3. Tensile and Compressive Strength

- MS (Mild Steel) has high ductility and can withstand tensile (pulling) and compressive (pushing) forces without failing.
- This is key in bridge decks, structural panels, or machine base plates.

4. Weldability and Fabrication

- Mild steel's low carbon content (~0.15–0.25%) makes it highly weldable and easy to cut or form.
- Plates can be shaped or joined into larger components with minimal effort.

**Material Properties That Define Its Behavior**

| Property | Value / Description |
|---|---|
| Yield Strength | ~250 MPa (can vary by grade) |
| Ultimate Strength | ~400–550 MPa |
| Density | ~7.85 g/cm³ |
| Elastic Modulus | ~200 GPa |
| Elongation at Break | ~20–25% (good ductility) |
| Carbon Content | ~0.15% to 0.25% |

### 3.6 Fabrication Process

The fabrication of a manual roller bending machine involves a series of steps that include planning, design, material selection, machining, assembly, and testing. These machines are commonly used to bend metal sheets or rods into curved shapes manually using mechanical advantage from hand cranks and rollers.

Below is a step-by-step outline of the fabrication process:

**1. Planning and Design**

- Define requirements: Maximum thickness and width of metal sheet, material to be bent, radius of curvature.
- Design the machine using CAD software. Key components include:
    - Frame (base and supports)
    - Rollers (top and bottom)
    - Gear or chain drive mechanism
    - Hand crank
    - Adjustment screw (for top roller)
- Create detailed engineering drawings.

**2. Material Selection**

- Mild steel for the frame (strong, weldable).
- Hardened steel or stainless steel for the rollers (to resist wear).
- Bearings, shafts, nuts, bolts, and bushings.

**3. Fabrication Process**

a. Frame Construction

- Cut steel plates and channels to size (using cutting torch, angle grinder, or bandsaw).

- Drill holes for bolts or welding points.
- Weld or bolt the base and vertical supports to form a rigid frame.

b. Machining the Rollers
- Select round bars of appropriate diameter.
- Machine them using a lathe to smooth and size them.
- Add grooves (if needed) for wire or rod bending.
- Drill shaft holes through rollers.

c. Shaft and Bearings
- Machine shafts to fit roller holes.
- Install bushings or bearings to allow smooth rotation.
- Mount rollers on shafts and assemble into the frame.

d. Adjustment Mechanism
- Fabricate a screw-based vertical adjustment for the top roller.
- Use threaded rods with handle nuts or T-screws.
- This allows the operator to vary the pressure and curvature.

e. Drive Mechanism
- Attach a hand crank to the lower roller.
- Use sprockets and chain, gears, or simple coupling to rotate both bottom rollers simultaneously.
- Ensure alignment and smooth transmission.

**4. Assembly**
- Assemble all components per the design.
- Check alignment of rollers.
- Grease bearings and moving parts.
- Tighten all bolts and secure welds.

**5. Testing and Finishing**
- Test the machine with a sample metal sheet.
- Check for proper curvature and smooth roller action.
- Make adjustments if necessary.
- Paint or coat the frame to prevent rust.

**Optional Enhancements**
- Scale markings for adjustment.
- Quick-release clamps.
- Safety guards on gears/chains.
- Portable wheels for mobility.

## THE MANUAL ROLLER BENDING MACHINE



**Figure: Manual Roller Bending Machine**

# Chapter 04 Fabrications Process

## 4.1 Introduction

The fabrication of the manual roller bending machine was carried out in several steps starting from material preparation to final assembly. Basic hand tools and workshop equipment were used during the process.

## 4.2 Fabrication Steps

### Step 1: Frame Construction

- Mild steel angle bars were cut to required lengths.
- The base frame was welded into a rectangular structure.
- Vertical supports were added to hold the roller shafts.

### Step 2: Roller Preparation

- Steel rods were machined to form smooth cylindrical rollers (3 units).
- Shafts were fixed to the rollers using welding.
- Keyways were added for fitting with gears and handle.
- **Step 3: Bearing Housing**
- Holes were drilled into the side supports to install bearings.
- Bearings (6204 type) were fitted to allow smooth roller rotation.
- **Step 4: Gear and Handle Installation**
- A simple gear system was connected to one of the rollers.

- The handle was attached to this gear shaft for manual rotation.
- Gears ensured synchronized movement of rollers.

**Step 5: Adjustable Mechanism Setup**

- The middle roller was made vertically adjustable.
- A threaded rod and nut arrangement was installed to control pressure.

**Step 6: Finishing and Testing**

- All parts were checked for alignment.
- Rust-prone parts were painted.
- The machine was tested using metal strips to check bending performance.

### 4.3 Tools and Machines Used

- Welding machine
- Grinding machine
- Drill machine
- Lathe (for roller machining)
- Measuring tools (scale, caliper)

# Chapter 05 RESULT & DISCUSSION

## 5.1 Project Analysis

The Manual Roller Bending Machine works based on the three-roller bending mechanism. The metal sheet or rod is placed between the rollers. By rotating the handle, the sheet passes through the rollers. The center roller is adjustable and applies downward force, causing the sheet to bend gradually as it moves forward. The two bottom rollers support the sheet. The top roller pushes the sheet downward, creating the desired curve. Continuous rotation bends the material in a smooth arc. This method allows controlled and uniform bending without damaging the material.

## 5.2 Operation Procedure

1. Setup: Adjust the distance between the rollers based on material thickness.
2. Loading: Place the metal sheet or rod between the rollers.
3. Adjustment: Lower the center roller to apply initial pressure.
4. Rotation: Turn the handle slowly to feed the material forward.
5. Repeat: If a tighter bend is needed, repeat the process with increased pressure.
6. Unloading: Once the desired bend is achieved, remove the material.

## 5.3 Safety Measures

- ❖ Always wear gloves and eye protection during operation.
- ❖ Do not overload the machine with thick materials beyond its capacity.
- ❖ Make sure all bolts and rollers are properly tightened before use.
- ❖ Keep hands away from rollers during operation.

# Mathematical Calculations

## 1.1 Bend Allowance (BA)

$BA = \theta \times ((R + K \times T) / 180) \times \pi$

**Where:**

- ❖ θ: Bend angle (degrees)
  - R: Inside bend radius
  - T: Material thickness
  - K: K-factor (typically 0.3 to 0.5 for most steels)

## 1.2 Flat Length (L)

$L = L1 + L2 + BA$

**Where:**

- ❖ L1 and L2: Straight sections before and after the bend
  - BA: Bend allowance

## 1.3 Bending Force

$F = (K \times \sigma y \times T^2 \times W) / D$

**Where:**

F: Bending force
- K: Constant depending on tooling (usually 1.33)
- σy: Yield strength of material (MPa or $N/mm^2$)
- T: Sheet thickness (mm)
- W: Width of the sheet (mm)
- D: Die opening or distance between rolls (mm)

## 1.4 Radius of Curvature from Roller Positioning

$R = (d^2 + 4h^2) / (8h)$

**Where:**

- ❖ d: Distance between the bottom rollers
  - h: Depth of indentation of the top roller

## 2. Sample Calculation Table

| S. No | Material | Thickness (T) mm | Width (W) mm | Yield Strength (σy) MPa | Bend Radius (R) mm | Bend Angle (θ) ° | Flat Length (L) mm | Force (F) kN |
|---|---|---|---|---|---|---|---|---|
| 1 | Mild Steel | 2.0 | 1000 | 250 | 10 | 90 | 1045 | 3.5 |
| 2 | Aluminum | 1.5 | 800 | 150 | 8 | 180 | 1600 | 1.2 |
| 3 | Stainless | 3.0 | 1200 | 500 | 15 | 60 | 1255 | 7.2 |

### 6.1 Performance

**Analysis**

- Efficiency: Manual operation was smooth and did not require high effort.
- Precision: Bends were consistent in radius and alignment.
- Stability: The machine frame remained stable with no visible deformation.
- Limitations: Thick materials (above 2.5 mm) were harder to bend manually and required more effort.

### 6.2 Comparison with Expectations

The results matched the design expectations. The machine was successful in achieving the following:

- Lightweight and portable structure
- Ability to bend various materials
- Easy and safe manual operation

“The performance shows that the machine is suitable for small workshops, educational labs, and rural fabrication tasks.

# Chapter 06 CONCLUSION AND RECOMMENDATION

## 6.1 Conclusion

The project successfully achieved its goal of designing and fabricating a manual roller bending machine suitable for small-scale metal bending tasks. The machine is simple in design, low in cost, and effective in bending mild steel and aluminum sheets with good accuracy.

Key achievements include:

- A fully functional, hand-operated roller bending mechanism
- Capability to bend various materials up to 2–2.5 mm thickness
- Stable structure and smooth operation

"This machine can be especially useful in rural workshops, technical training institutes, and small fabrication units.

## 6.2 Recommendation

Based on the results and performance, the following improvements are suggested for future development:

- Add a scale or indicator for precise roller adjustment
- Use higher-grade steel for rollers to increase lifespan
- Consider motorizing the handle for semi-automatic operation
- Improve the base for better grip and reduced vibration during use

With these enhancements, the machine could serve in more advanced applications and handle thicker materials with ease.