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DESIGN & ANALYSIS OF PORTABLE INJECTION MOLDING MACHINE

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Abstract— The design and analysis of a portable injection moulding machine that will satisfy the demands of educational institutions and small-scale industries is the main goal of this project. A small and easy-to-use injection moulding technique is required due to the growing need for adaptable and effective manufacturing solutions. In order to improve portability without sacrificing performance, this study describes the creation of a machine that uses cutting-edge materials and creative engineering techniques.

A sturdy yet lightweight structure, an effective heating and cooling system, and an easy-to-use control interface are important design elements. To ensure optimal operation under a variety of settings, Finite Element Analysis (FEA) is used to assess the machine's thermal efficiency and structural integrity. The machine's ability to create high-quality moulded parts with shorter cycle times is demonstrated by performance testing with various thermoplastics.

The machine is affordable when compared to its conventional counterparts, according to the economic analysis, which makes it available to start-ups and educational initiatives. By highlighting the value of flexibility and creativity in manufacturing processes, this study advances the continuous development of injection moulding technology.

Keywords— Plastic injection molding, molding machine, CAD, CAE, Structural analysis, machine design, Solid works.

I. INTRODUCTION

In the industrial industry, injection moulding has long been recognised as one of the most efficient and versatile processes for producing plastic components. The large, expensive, and high-volume nature of injection moulding equipment makes them unaffordable for small businesses, research labs, and educational institutions. However, more affordable and compact alternatives have been developed in response to the growing demand for flexible and affordable production solutions, particularly for small-batch manufacturing and rapid prototyping.

The Value of Portability

For a number of reasons, the idea of mobility in injection moulding has become crucial.

• Accessibility: Smaller companies and academic institutions frequently lack the funds necessary to purchase massive, industrial-grade equipment. Access to cutting-edge manufacturing technologies can be made more accessible through portable devices.

• Flexibility: On-site production made possible by portable machinery cuts lead times and transportation expenses. Small batch production and prototyping particularly benefit from this.
• Innovation in Design: As users may test out novel concepts without taking large financial risks, the move towards smaller machines encourages innovation in product design and development.

Crucial Elements of an Injection Moulding Device:

• Injection Unit: The plastic must be melted and injected into the mould using this part. It is made up of a screw for feeding and mixing the plastic, a barrel for heating and melting the material, and a hopper for loading plastic pellets.
• Clamping Unit: During injection and cooling, the clamping unit maintains the mould halves together under tremendous pressure. During the ejection stage, it also opens and closes the mould. Depending on the type of machine, clamping can be powered by pneumatics, hydraulics, or electro mechanics.
• Mould: The mould is a specially made instrument that establishes the final product's shape. Usually composed of steel or aluminium, it is divided into two parts: the cavity and the core.
• Control System: To manage variables including injection speed, pressure, temperature, and mould opening/closing cycles, contemporary injection moulding machines employ computerised control systems. These systems guarantee the process' accuracy and consistency.

II. OBJECTIVE

The primary objectives of the project on designing and analysing a portable injection moulding machine are as follows:

- Design a Compact and Efficient Machine
- Conduct Comprehensive Mechanical Analysis
- Promote Educational and Practical Applications

III. METHODOLOGY

• CAD Modelling

In Cad Modelling, The portable injection moulding machine was conceptualised and digitally assembled using computer-aided design (CAD). Prior to production, the modelling procedure made sure that component interferences, ergonomic concerns, and spatial limitations were taken into account. SolidWorks 2018's assembly capabilities were used to create the CAD model.

The following subsystems were included in the machine's design:

• Injection Unit: Consists of a heated barrel, hopper, nozzle, and plunger screw. With built-in cartridge heaters, the barrel was made to hold thermoplastics like ABS and HDPE.
• Clamping Unit: Enough force is provided by a screw-locking or toggle-based mechanism to hold the mould halves firmly closed during injection.
• Frame: Designed for stability and portability, the main support structure is constructed from steel brackets and aluminium profiles.
• Mould Assembly: The nozzle is compatible with a standard two-plate mould. The design includes provisions for ejector pins.

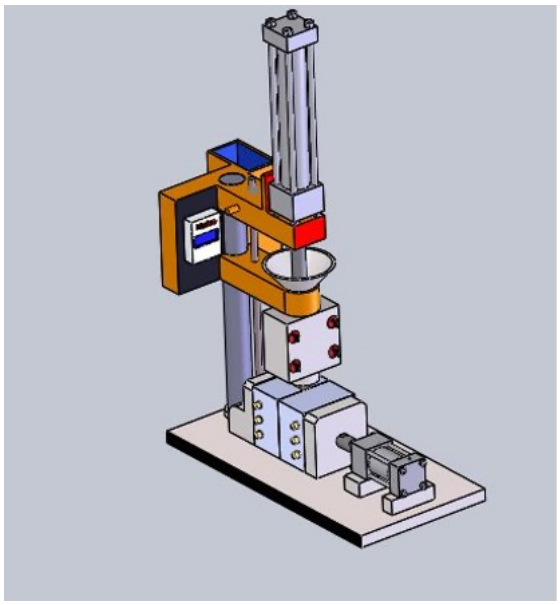

Fig. 1 CAD Model of Portable Injection Molding Machine

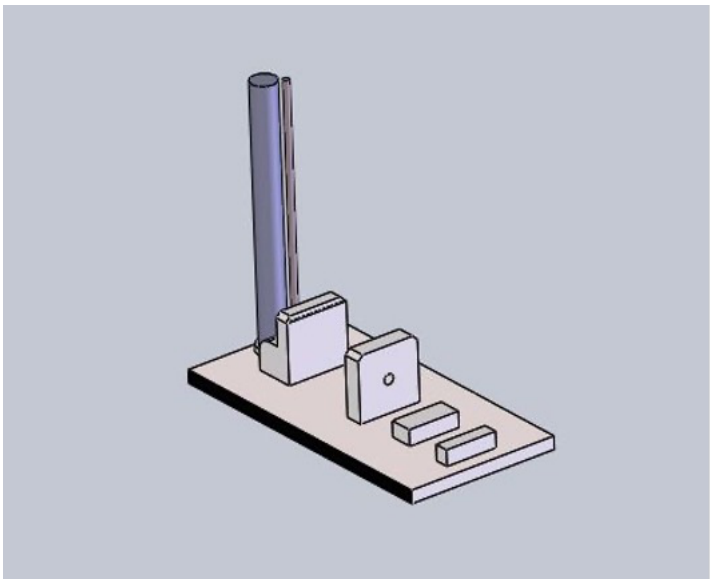

Fig. 2 Frame of Portable Injection Molding Machine

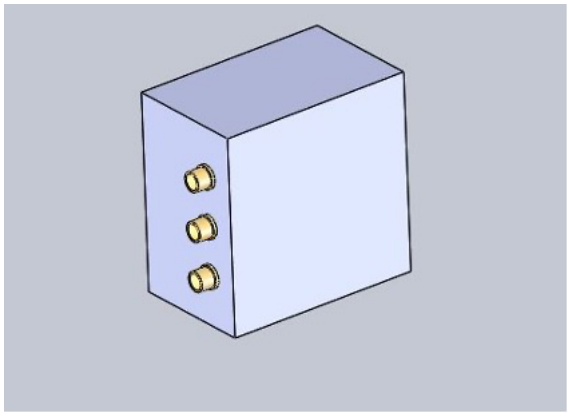

Fig. 3 Die of Portable Injection Molding Machine

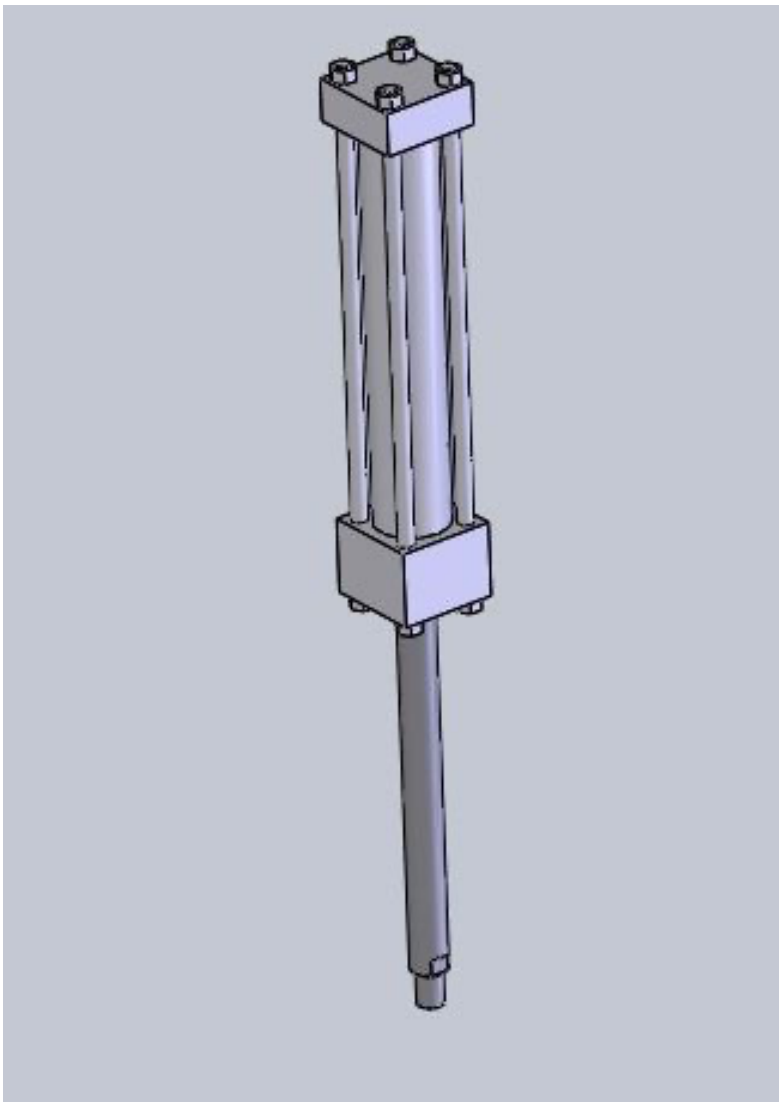

Fig. 4 Vertical Cylinder

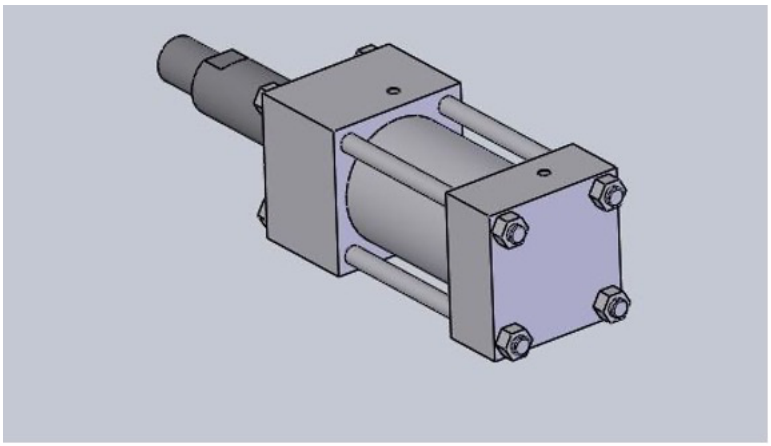

Fig. 5 Horizontal Cylinder

- **Analysis of Portable Injection Moulding Machine**

The goal of the structural analysis is to make sure that the injection barrel, clamping frame, and mould plates—three essential parts of the portable injection moulding machine—can sustain operating forces without yielding or deforming too much.

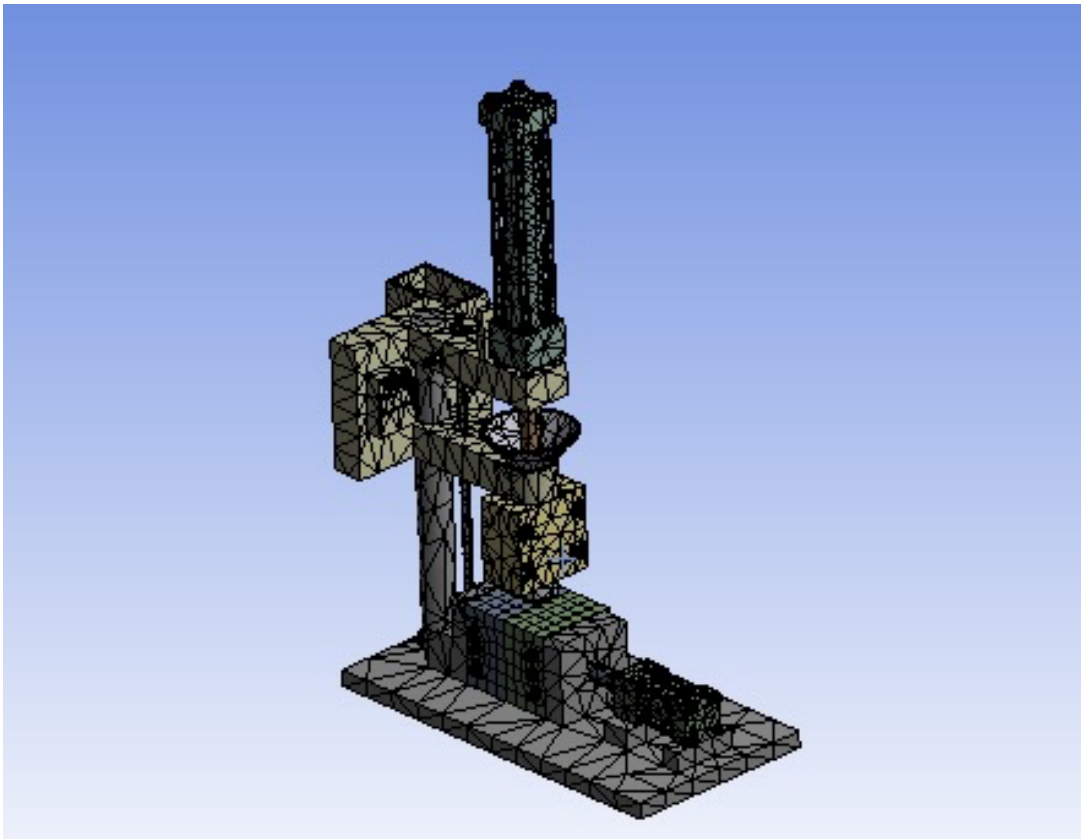

Fig. 6. Mesh Model

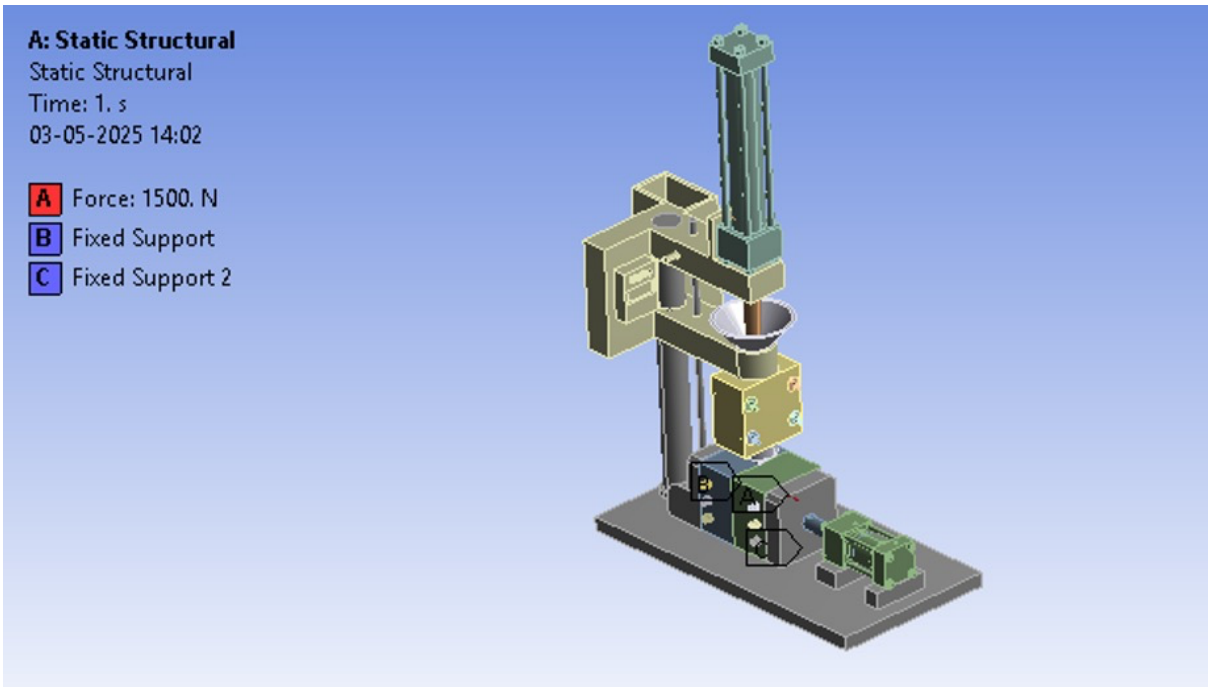

Fig. 7. Boundary Condition

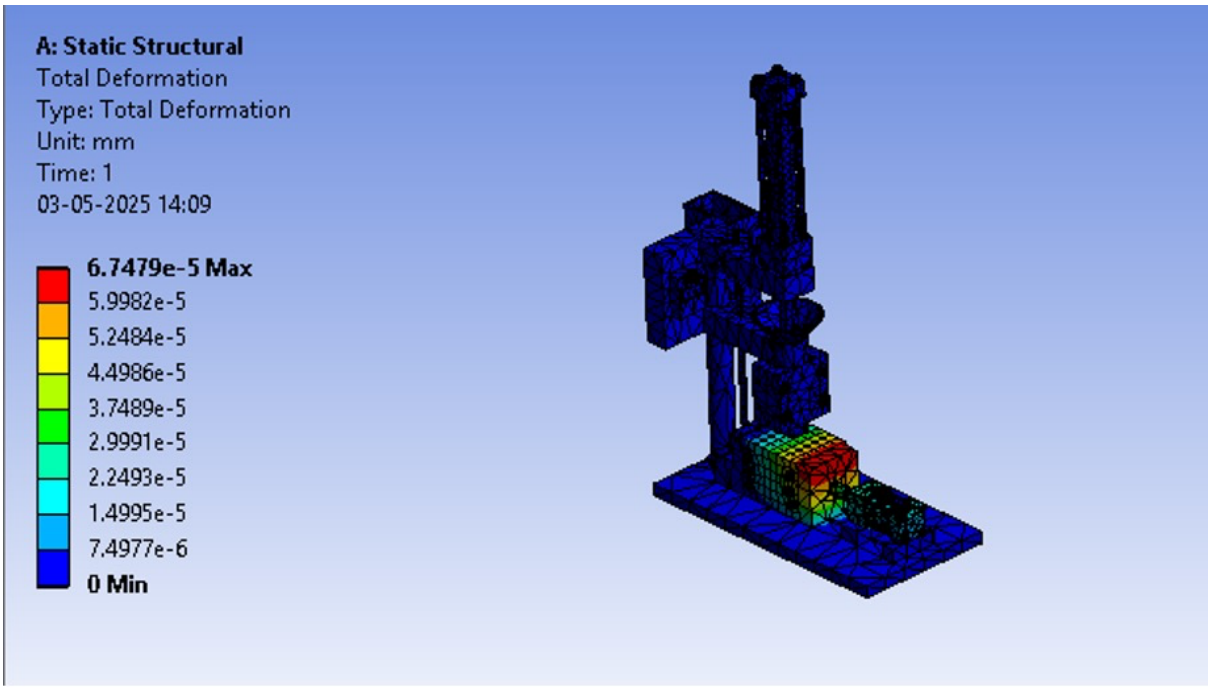

Fig. 8. Total Deformation

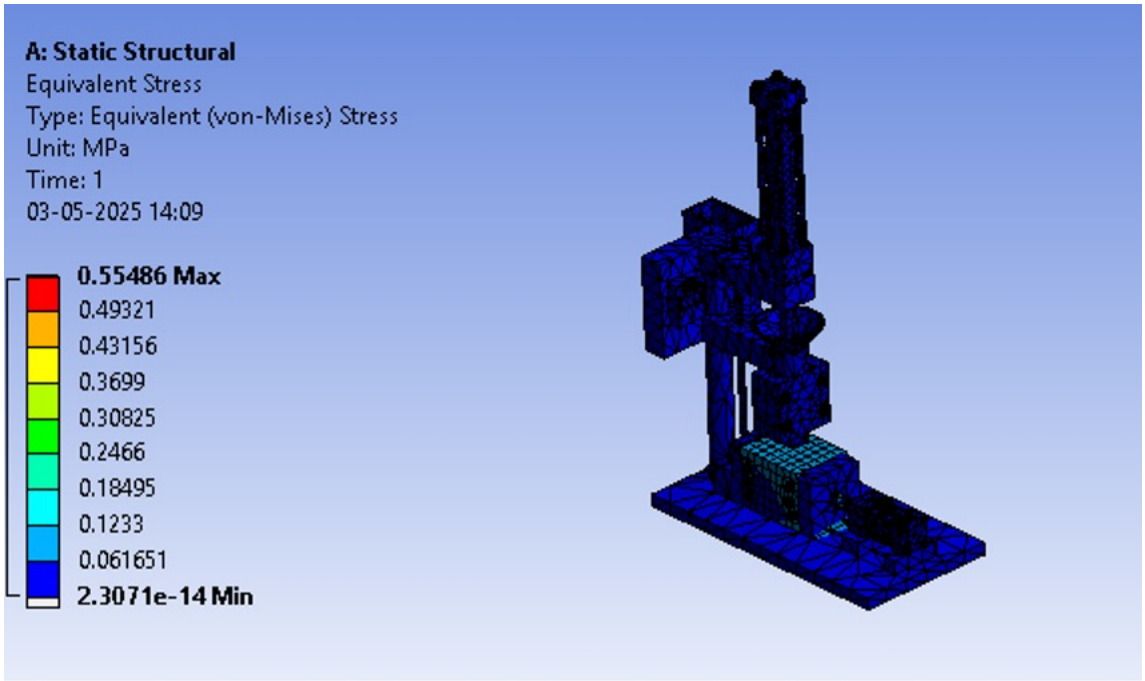

Fig. 9. Equivalent Stress

IV. CONCLUSIONS

A portable injection moulding machine's design and structural analysis have been successfully completed to satisfy the needs of mechanical dependability, compactness, and low-volume manufacturing. CAD tools were used in the machine's design to guarantee correct component alignment, functionality, and simplicity of assembly. Finite element analysis (FEA) was used to model and analyse important parts such the injection barrel, mould base, and clamping frame in order to replicate actual operating circumstances.

Excellent structural safety was shown by the structural analysis's findings, which showed a maximum stress of just 0.5548 MPa—much lower than the materials' yield strength (such as mild steel or tool steel). Furthermore, only 0.006 mm of total deformation was seen, indicating that the machine can retain exact mould alignment while operating and verifying minimum deflection under load.These results show that the portable injection moulding machine is safe for everyday use, extremely stable, and mechanically strong.

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