iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** X **Month of publication:** October 2023

DOI: https://doi.org/10.22214/ijraset.2023.56058

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue X Oct 2023- Available at www.ijraset.com

Design of Can Crusher

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Abstract: Present study has focused on the design of a domestic aluminum can crusher this will be used to shred empty beverage cans and recycle them back into the industry. It promote sustainability in the beverage production sector. The Young's modulus, density, yield strength, and Poisson's ratio of steel and aluminum, among other parameters, were taken into consideration during the design computation of the crusher. Catia was used to model each individual component as well as the entire machine assembly.
Keywords: CATIA Software, Production, Machine, Modelling, Stress Analysis.

I. INTRODUCTION

A well-known strategy for sustainable manufacturing is the lean production system. This is demonstrated by the decrease in waste and environmental degradation, particularly when beverage cans are recycled. Production companies for food and drink have struggled to recycle their trash, which has harmed the environment. Despite being used to reinforce and stabilize engineering constructions, crushed beverage cans are still difficult to harvest locally and transform into useful forms due to a lack of the requisite tool.

The size and micro-fracture will be taken into consideration during the design of the crushing machine, which will aid in the crushing process. Additionally, for greater efficiency, the machine's design can appropriately accommodate the impact force needed to crush the beverage. Consequently, the rate of can loss recovery during production will increase, and pollution will be avoided. The productivity, rate of can recovery, and environmental protection are all improved by crushers with sufficient capacity and dependable power. Uncompressed cans take up a lot of room, therefore it takes inventive and imaginative thinking to put parts together into a dependable machine for crushing aluminum cans. Therefore, trying to smash aluminum cans with your bare hands or feet will undoubtedly waste your time and effort.

As a result, crushing aluminum cans relies on compression principles, and designing a crusher requires a thorough understanding of the dynamic forces at play.

However, it is feasible to forecast the stress applied, learn about the machine's operation performance, and calculate the wear of the crusher by simulating the behavior of the crushing process. The variation in crushing behavior as a function of can height during compression is essential for determining the crushing stress. This significantly affects the mechanical characteristics and may deformation shape. Furthermore, the fact that the machine's bulk induces strain hardening as a result of the dynamic reaction to crushing is crucial to engineering design.

This product is easily manufactured and has a straightforward construction. Even a layperson can use the crusher because of the way it was constructed. In comparison to other machines, the cost of production and maintenance is quite low. The garbage may be effectively crushed in this crusher. This crusher is best suited for crushing tiny and straightforward materials like paint cans, soda cans, aluminum tins, machining scrap, sheet metal trash, etc. in small recycling plants, small companies, and shopping malls.

II. LITERATURE REVIEW

We present that literature survey of can crushing techniques and how they are implemented.

The currently available crushers are large and heavy, and they are frequently employed in large companies and manufacturing facilities to crush materials such as vehicles, stones, metal parts, etc. These crushers are also hydraulically and pneumatically controlled, making them practical if a large number of crushing forces are needed to smash a material. These high-end crushers are not required for small recycling operations and are out of reach for the majority of people due to their high operating expenses, which arise from the fact that they require continuous power and maintenance that entails hydraulic fluid or compressor kits, among other things. Because the hydraulic fluid must be replaced regularly and continually, it needs to be well maintained. For operation, it also needs specialized labor.

For our project, we have design of a domestic aluminum can crusher.

Research project by [1] successfully developed model of a jaw crusher. The objective of the study is to develop a reliable simulation model that can accurately predict the behavior and performance of a jaw crusher in an industrial setting

Further [2] focuses on the energy absorption and in-plane crushing behavior of aluminum reinforced honeycomb structures. The objective of the study is to investigate the mechanical properties and performance of these structures under crushing conditions.It highlight the potential of these structures in various industries where lightweight materials with high energy absorption capabilities are required.

The study utilizes the Discrete Element Method,[3] a numerical technique that enables the simulation of individual particles and their interactions within a system. The authors employ this method to model the behavior of particles in crushers, taking into account factors such as particle shape, size, and mechanical properties.

The research paper [4] presents a study on the dynamic crushing behavior of multilayer thin-walled aluminum corrugated cores. The findings demonstrate the energy absorption capabilities and deformation mechanisms of these structures, providing insights for their application in impact protection systems.

The models developed through this approach provide valuable insights into crusher behavior, aiding in design optimization and process control. [5] The research contributes to the field of crusher engineering, with potential applications in various industries.

The authors [7] highlight the growing demand for sustainable packaging solutions, particularly in the beverage industry. Self-chilling beverage cans offer the unique feature of cooling the drink without the need for external refrigeration, making them an attractive alternative to traditional cooling methods.

III. METHODOLOGY

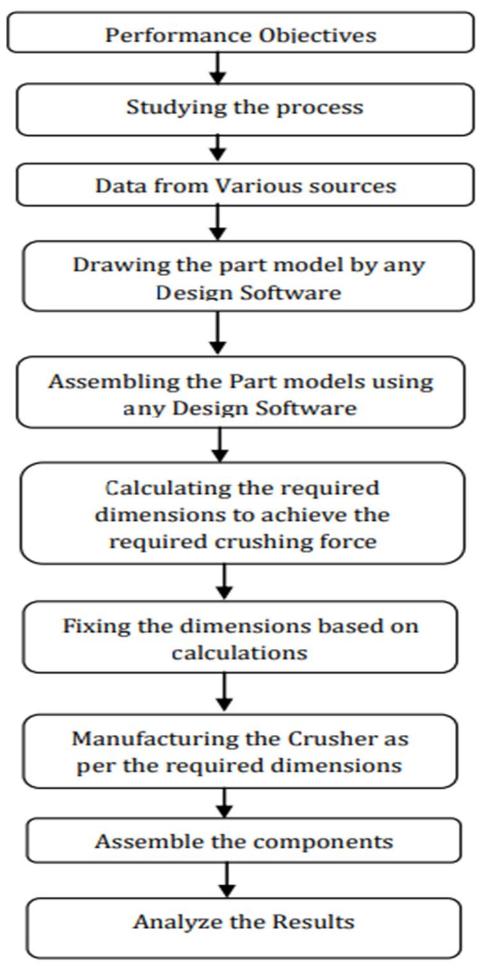

Fig 1 : Work Methodology

IV. MATERIALS AND METHODS

The can crusher mechanism is modelled using Aluminium material [5].Table 1 presents the structural properties of Aluminium material used in the design. For domestratation of developed technique we have considered can of diamensions as shown in table 2.

We have choose aluminium because it offering a combination of lightweight, strength, corrosion resistance, recyclability, availability, and aesthetic appeal.

A. Material Selection and Description of Properties

1.	Young's modulus (GPA)	75
2.	Density Kg/m^3	2700
3.	Tangent modulus (MPA)	28
4.	Yield Strength (MPA)	60
5.	Poisson's Ratio	0.303

Table 1 - Properties of Aluminium

1.	Radius	3.3
2.	Height	12.1
3.	Thickness	0.25
4.	led Thickness	0.3
5.	Bottom thickness	0.3

Table 2 - Dimensions of the Can

V. MATHEMATICAL ANALYSIS OF CAN CRUSHER

Can crusher is presented in this project,

Force required to crush is calculated by Eulers column equation

$F= \pi^2 EI/L2$……………..(1)

Where,

E= young's modulus (Gpa)

I= mass moment of inertia (m)

L= length of column (cm)

F= force applied (N)

$E = 69 \times 109\ N/m^2$

L = 0.121 m

To calculate the mass moment of inertia which is given by the equation;

$I = \pi d^4 /64$………………….(2)

Therefore,

$I = \pi \times 0.003^4/64$…………………(3)

$=3.976 \times 10^{-12}\ m^4$

Hence the force will be
$F= \pi^2 EI/L^2$
$(\pi^2 . 69. 10^9 . 3.976 \times 10^{-12}) / 0.121^2 =184.937N$
The Compressive stress effect by the crushing surface can be evaluated using
Stress= Force/ Area………………(4)
Where, Area of Can
$A= 2\pi rh+2\pi r2$…………………..(5)
$2.\pi \cdot 3.3 \cdot 12.1+2 \cdot \pi \cdot 3.32=319.31148$
Therefore,
Compression Stress = Force/ Area……………(6)
Stress = $579.1N/m^2$

VI. DESIGN OF CAN CRUSHER

A. Part Design and Assembly

Part design and assembly is simulated using catia software v5 version .we have considered $1/5^{th}$ of the real product dimensions for our assembly

Following is the detailed implementation regarding part simulation and part usage

1) Back plate

Used to provide stiff support for the piston that is used to crush the can and to support the support beams.

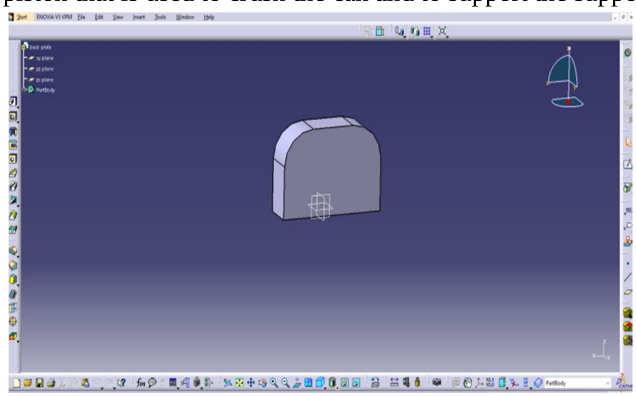

Fig 2. Back plate

2) Base Plate

The can crusher's base, which supports all of its components, has a slit on the back plate side for removing crushed cans.

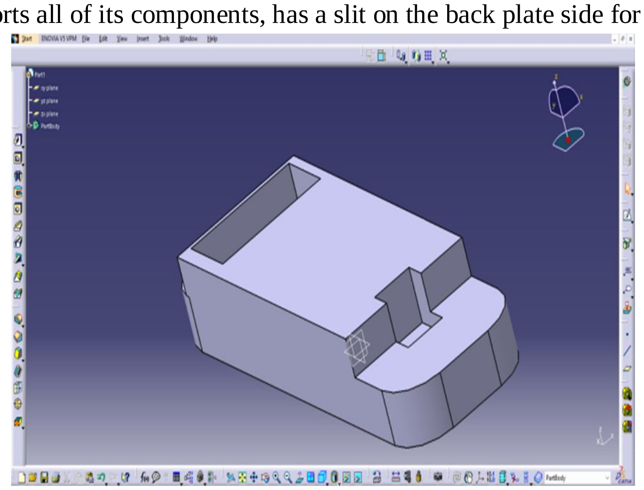

Fig 3. Base plate

3) Support Beam

Use to support and guide the piston so that it can't travel in any other direction and correctly crush the can. It basically consists of a horizontal Support and an axis that is parallel to the piston.

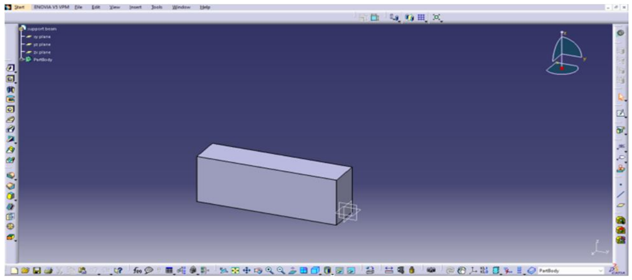

Fig 4. Support beam

4) Handle Fixture

Use to give fix support to handle by which it should not move and give proper movement to crush the can.

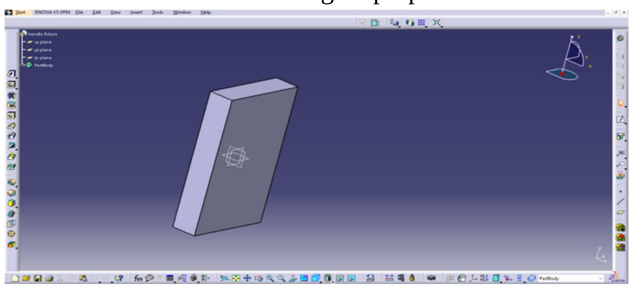

Fig 5. Handle Fixture

5) Handle

The piston can slide and crush with the aid of this component. Two strips are attached to the piston slot that is fixed in it, and the piston can move and crush with the aid of those two strips.

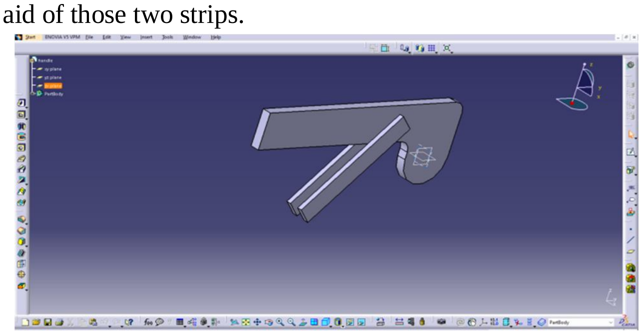

Fig 6. Handle

6) Piston

With the help of sliding motion crush the can. And there is 2 slots which use to fix handle strips and take momentum from it.

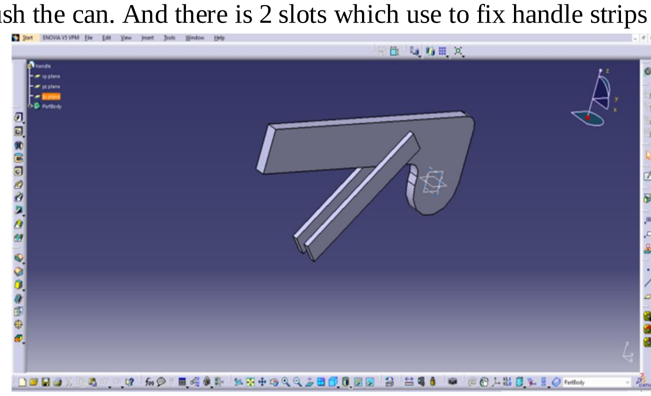

Fig 7. Piston

B. Assembly

As the parts mentioned are assemble together and fixed with the help of knails in the real time working model that we have develop. On base back plate and support beam perpendicularly placed and handle fixture is placed in the slot and give support to handle. Handle is placed between the handle fixture which is connected with strips connected to piston this is a cavity between the base plate and back plate.

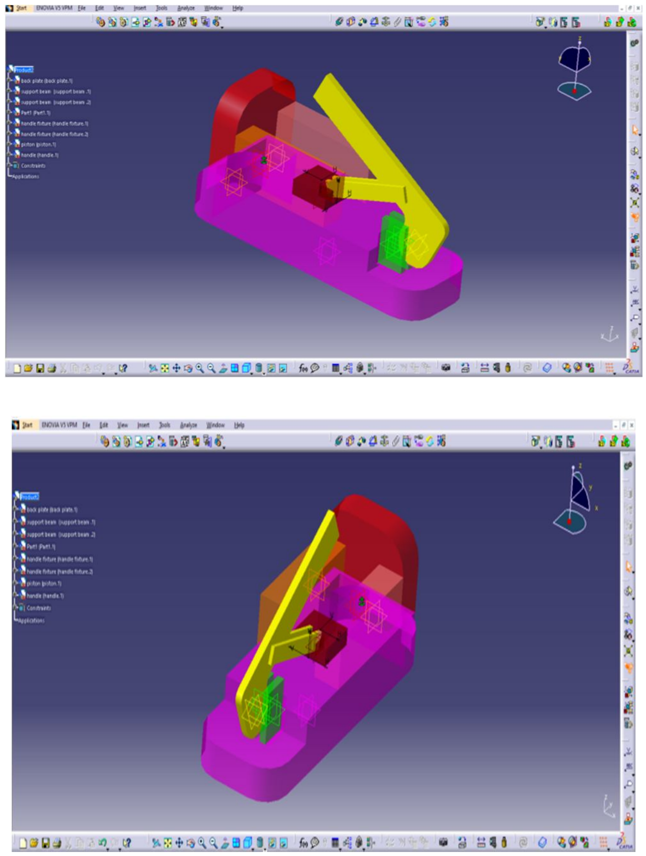

Fig 8. Assembly

VII. MODEL

Fig 9. Actual Mode

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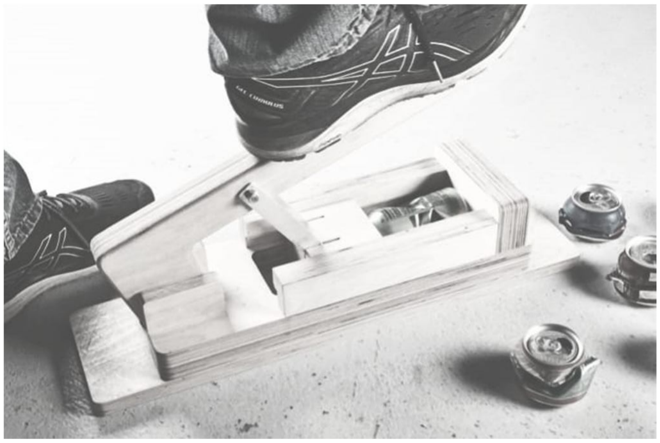

Fig 10.Can crush

VIII. RESULT

Force (N)	**% of can crush**
180.97	99.25
200	99.99

Original can volume (V_original) = πr^2h = π(3.3^2)(12.1) ≈ 400.84 cm^3
Crushed can volume (V_crushed) = (πr^2)(h - t) = (π(3.3^2)(12.1 - 0.25)) ≈ 397.10 cm^3

IX. CONCLUSION

The facts above lead us to the conclusion that the crusher will crush with a force greater than 200 N.

X. ACKNOWLEDGEMENT

We express or heartiest acknowledgement to all those who supported us and provided guidance whilst completion of this project. We would like to take this opportunity with great pleasure to express our deep sense of gratitude towards our guide Prof. S. M. Lambor for her valuable guidance and incessant encouragement and cooperation extended to us during this dissertation work.

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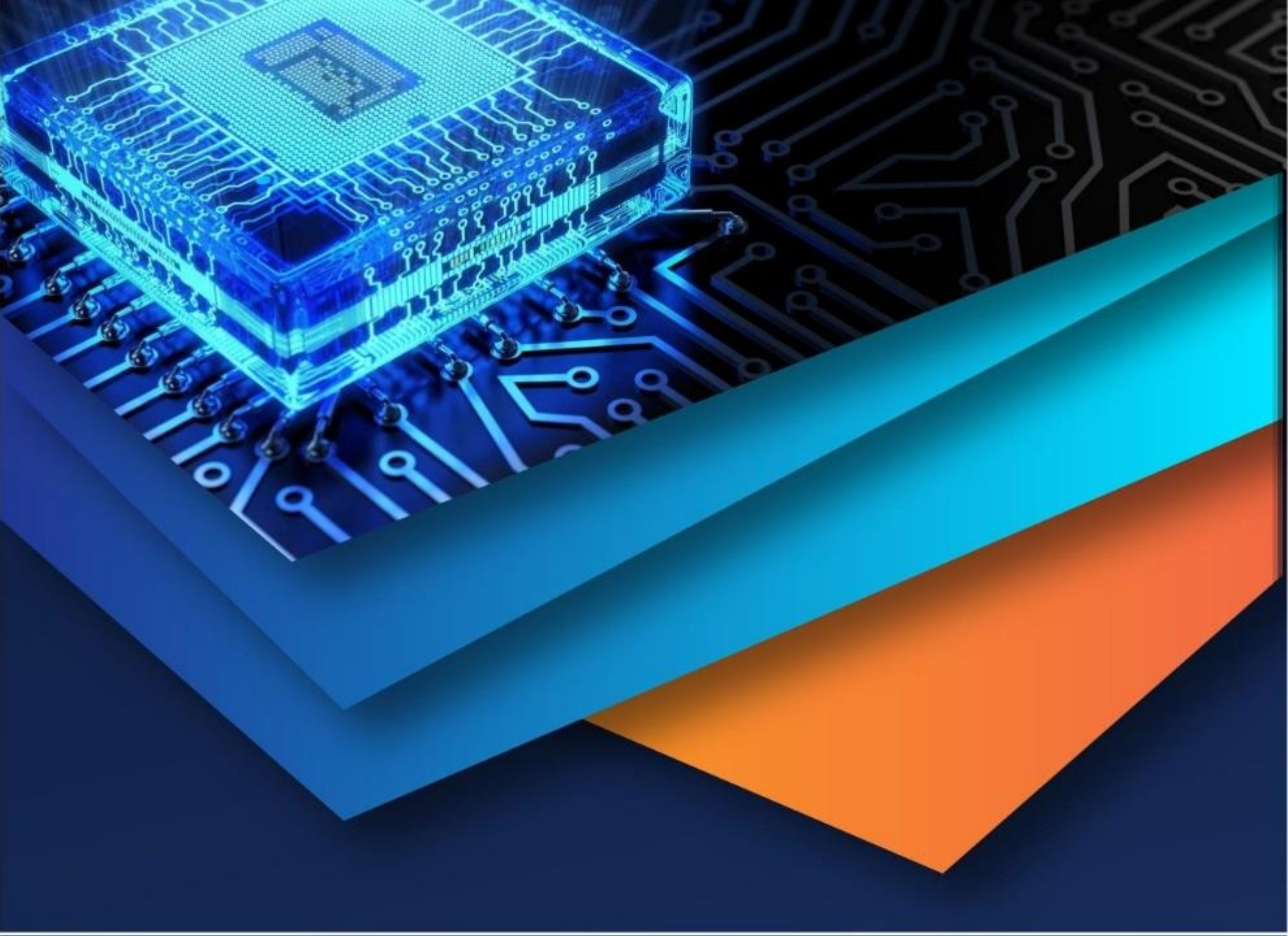

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