MODELLING AND ANALYSIS OF THE PORTABLE FOOT OPERATED BENDING PRESS FOR THIN SHEETS

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Abstract:

As we know the bending tools are hydraulic bending press tool and pneumatic bending press tool which are used for sheet metal operations. Those are well versed in bending operation for thick sheets but while performing the bending operation on thin sheets, it may fail because the hydraulic and pneumatic bending machine are more powerful than the hand or foot operated bending tools. So, it has less precision to apply low loads on thin sheets.In order to overcome these defects, there is a need for the development of the bending tool for thin sheets i.e., nothing but the portable foot press bending tool which is manual operated. It is to be modelled and analysed using Catia V5 Software.

The main objective of this concept is to reduce the cost of the sheet metal bending machine and to perform accurate sheet metal operation easily on thin sheets. It is more helpful especially for the small-scale industries as it reduces the equipment cost, tool cost, maintenance cost and it improves accuracy in bending sheets. Hence, it is proposed to model a portable foot operated bending press and analyse the optimum of the working conditions.

Key Words: Portable foot operated bending machine, thin sheet, foot lever, sliding punch holder

Literature Survey:

G. Arno ld, S. Calloch, D. Dureisseix, R. Billardon:

States that forming tool can be made to perform accurate bending tests on thin sheets for that any thin sheet can be transformed for initial stage to final stage which process is known as hardening. The architecture of the machine has enabled to measure the spurious loads in order to validate that the specimens are in a pure bending state.

AljosaIvanisevik, PlavkaSkakun:

Bending is the metal forming technology and it can be applicable on sheet metal forming and also in forming of wires, rods, strips, pipes and bars. Mostly it is used in car production, ship building and appliance of house hold appliance, and every sheet metal bending is most widely employed. For every forming process is done by the load applied and load released. So that we utilizes the manual load which is applied by the human leg.

Claudio L.Salvalaio, Fabio P.Silva, AlexandreS.Pinho, Mariana Pohlmann:

The research of "Evaluation of Qualitative Physical Effort on Bass Drum Pedal Drive by Thermography" states could serve as a basis for the suitability of the pedal drive technique, the development of appropriate footwear as well as the development of new products which will certainly reduce the health risks and improve the drummer performance. For this reference we prefers the foot liver for manual loads

Introduction:

A portable foot bending press is newly modelled for continuous bending operations on thin metal sheets. It works by the human load applied on the foot lever which slides the sliding punch holder downwards with aid of pivot point, and then the punch hits on thin sheet to deform into die shape as shown in Fig (1.1)

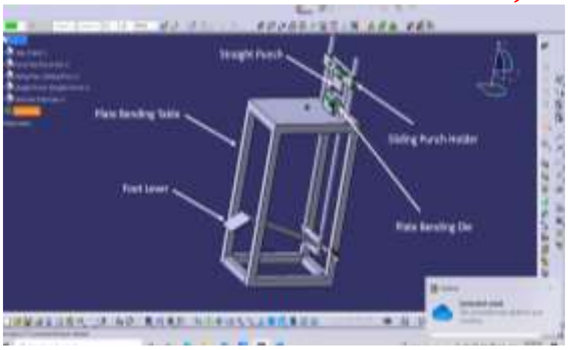

Fig (1.1) Portable Foot Bending Press

Components of portable foot bending press:

Portable foot operated plate bending press mainly consists Foot Lever, Bending Press Table, Die Holder, Guide Ways, Pivot point, Die and Punch, Sliding Push Holder, Springs

Parts Modelling & Assembly using CATIA V5:

For bending thin plates, we have considered straight punch in this project and considered size of straight punch 20mm thickness and 100mm length are standard straight punch sizes used in plate bending process

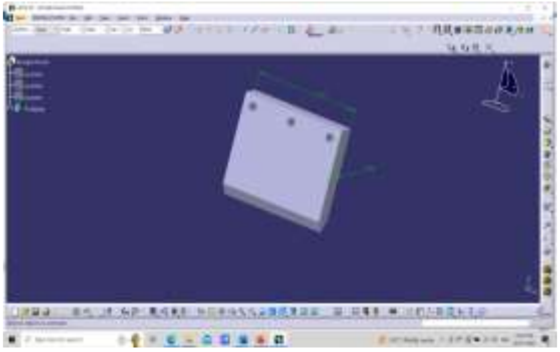

Fig (2.1) Straight Punch

Sliding punch holder with pulling rods along with foot lever converts rotary motion of the lever in to linear motion of the straight punch. Length of the foot lever is based on table height, ground clearance of foot lever and punch movement.

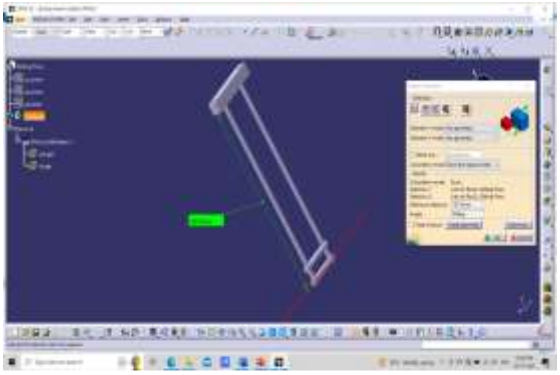

Fig (2.2) Sliding Punch Holder

Plate bending table supports all components and makes plate bending process easy. Plate bending table height is based on comfortable working height / waist height so that a person can easily place plate on die and remove once bending is complete. Length of the table is based on foot lever length

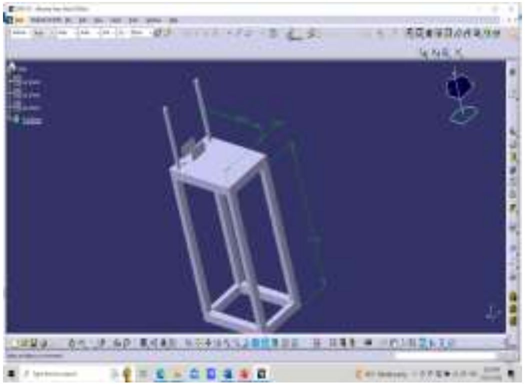

Fig (2.3) Plate Bending Table

Foot Lever transfers foot force to sliding punch holder and multiplies force by leverage principle. We have considered long foot lever of 575mm to achieve more than 16 times leverage load on plate

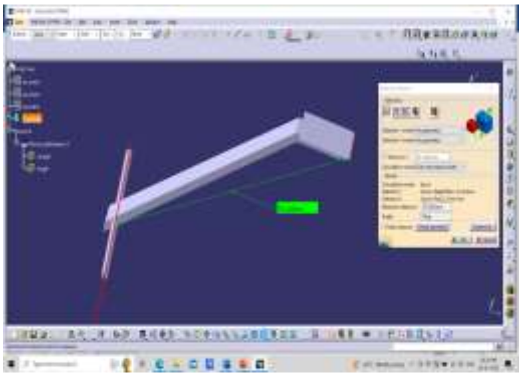

Fig (2.4) Foot Lever

After assembly portable thin plate bending press appears as shown in Fig (2.5)

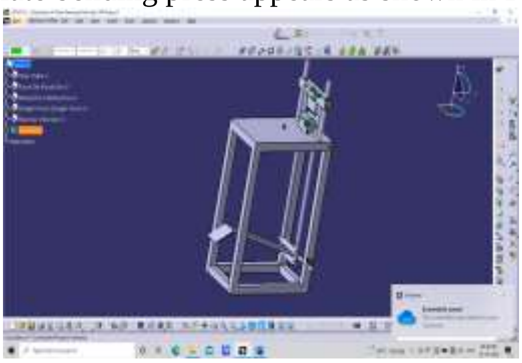

Fig (2.5) portable thin plate bending press

For bending thin plate of size not exceeding 100mm using Portable foot operated bending press, the thin plate should be placed over the die and adjust the marking to match with punch and then foot lever should be pressed to bend the thin sheet. As this machine applies less force compared to the hydraulic press, chances of thin sheets getting damaged will be reduced.

Calculation of force that can be applied on plate with leg:

Foot lever length from pivot = 575 = 0.575m

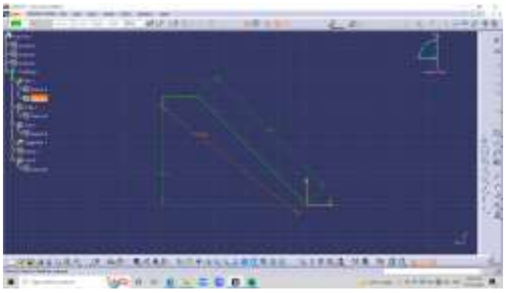

Fig (3.1) Foot lever length from pivot

Pulling rod centre distance from pivot (D) = 35mm

= 0.035m

Leg mass = 20Kg

Force applied on pedal = 20 x 9.81

= 196.2 N

Force acting on straight punch / plate = 3223.3N

= 3.223KN

3. Analysis:

Mild Steel material properties are applied to the 0.5 mm thick sheet as shown below

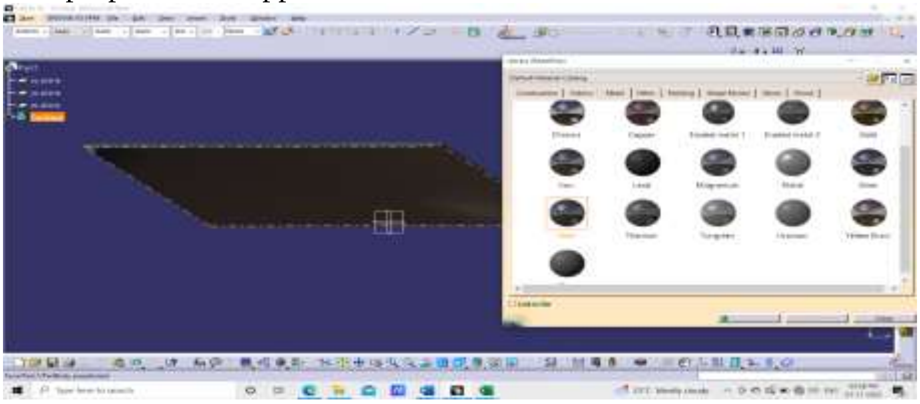

Fig (4.1) Mild Steel Material Application to Plate

Force of 3223N is applied at the centre of the plate as shown in Fig (5.2)

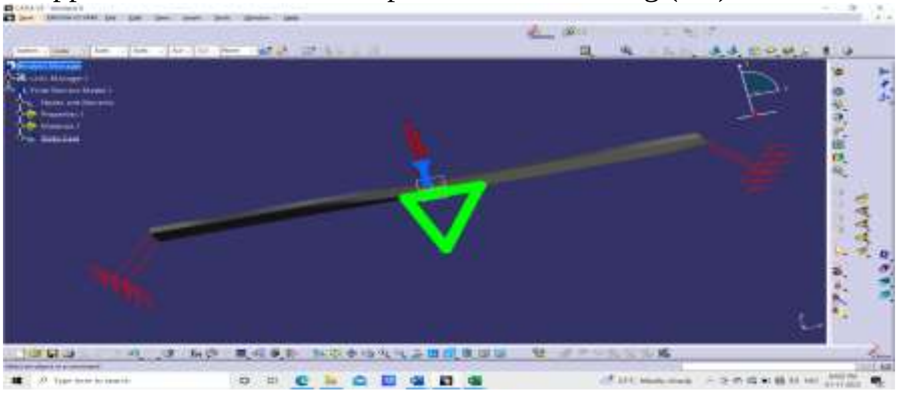

Fig (4.2) Application of the force to the mild steel plate

After running stress calculation Von-mises stress diagram of 0.5 mm thick mild steel plate is shown in Fig (4.3)

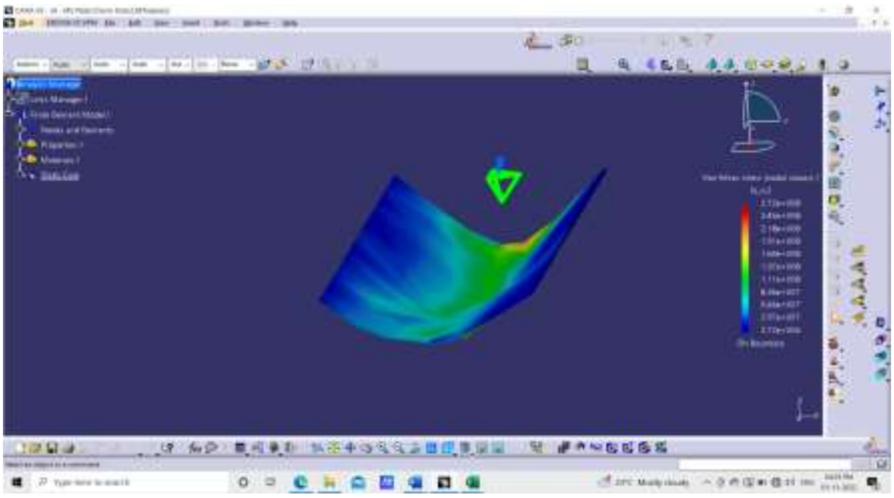

Fig (4.3) Von-mises stress diagram of 1mm thick mild steel plate

The same way analysis was conducted for Aluminium and Copper Plates and the Von-Mises Stress are present in Results & Discussions

Results and Discussions:

- In this project we have used foot lever to multiply the force applied by the leg. For example, if we apply a force of 196.2N (Equivalent to 20Kg) on foot pedal, a force of 3223N will be applied on plate due to leverage. To achieve such high leverage, we have considered 575mm long lever from pivot and 35mm distance for pulling rod centre.
- We have applied force of 3223N on 7 samples and analyzed the von-mises stress as presented below

Sample 1 (MS Plate / 0.5mm thick / 100mm Long):

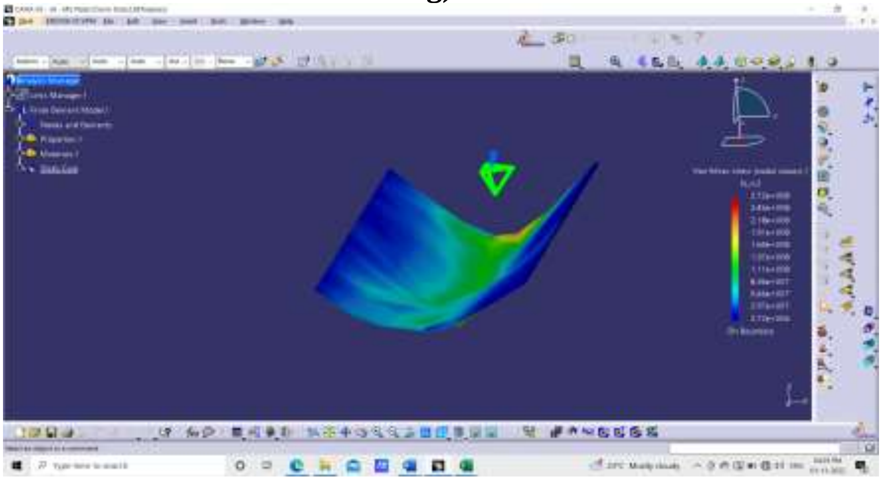

Fig (5.1) Stress on MS Plate – 0.5 mm thick

Sample 2 (MS Plate / 1 mm thick / 100 mm Long):

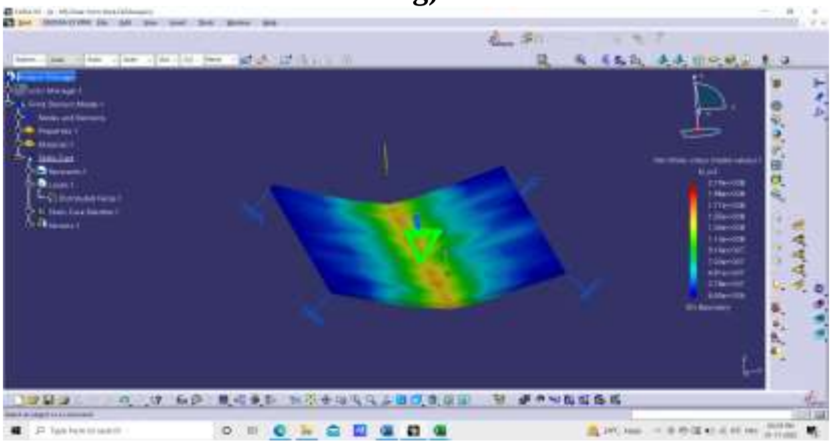

Fig (5.2) Stress on MS Plate – 1 mm thick

Sample 3 (Aluminium Plate / 0.5 mm thick / 100 mm Long):

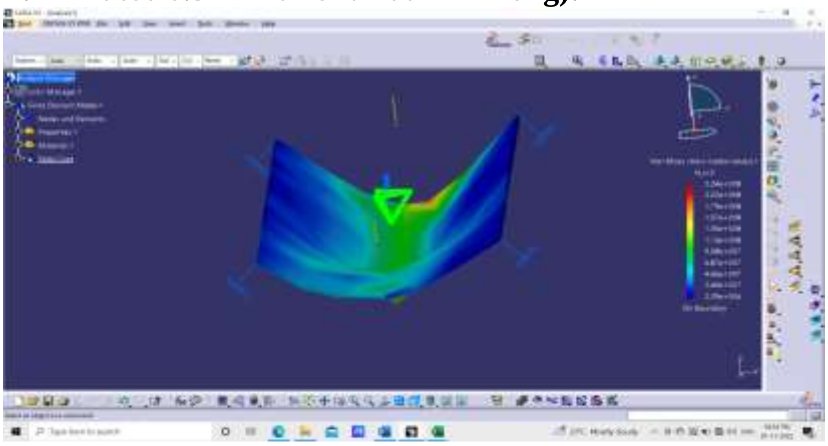

Fig (5.3) Stress on Al Plate
(0.5 mm thick)

Sample 4 (Aluminium Plate / 1 mm thick / 100 mm Long):

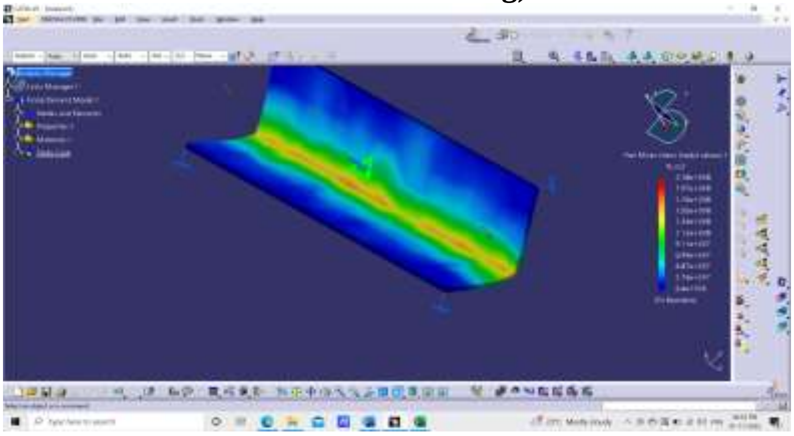

Fig (5.4) Stress on Al Plate – 1 mm thick

Sample 5 (Aluminium Plate / 3 mm thick / 100 mm Long):

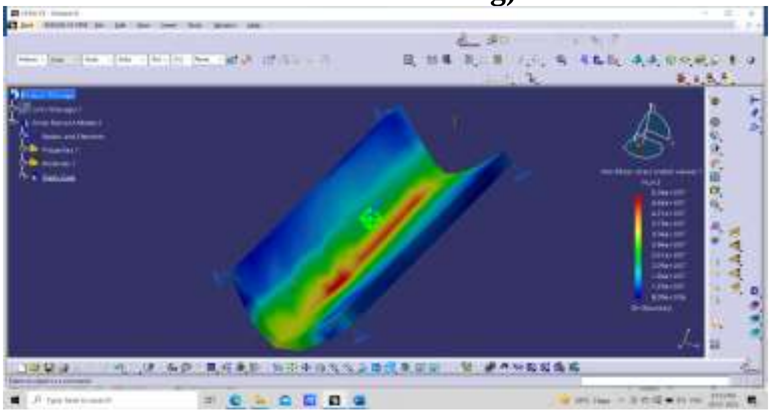

Fig (5.5) Stress on Al Plate – 3 mm thick

Sample 6 (Copper Plate / 0.5 mm thick / 100 mm Long):

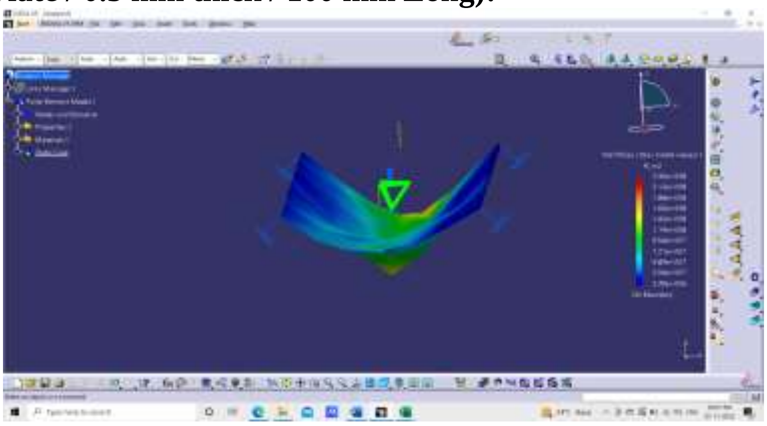

Fig (5.6) Stress on Copper Plate – 0.5 mm thick

Sample 7 (Copper Plate / 1 mm thick / 100 mm Long):

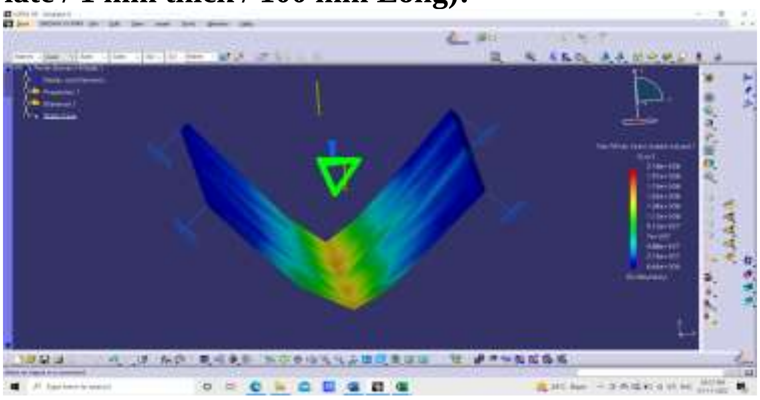

Fig (5.7) Stress on Copper Plate – 1 mm thick

- To compare the yield stress and Von-mises stresses of samples I have plotted values in below table

Sample No.	Material	Thickness (S) in mm	Yield Strength in MPa	Force Applied in N	Vonmises Stress in Mpa
1	MS	0.5	250	3223	272
2	MS	1	250		219
3	Al	0.5	11		224
4	Al	1	11		218
5	Al	3	50.6		506
5	Cu	0.5	33		235
6	Cu	1	33		218

Table 6.1 Yield Stress Vs Von- Mises Stress

- To bend the plate and to retain the plate in that shape it is required to apply the force that can make the plates Von-mises stresses cross its yield strength
- From above table it can be clearly seen that except sample 2 all other samples von-mises stress is more than their yield strength. That means the machine can easily bend samples 1,3,4,5 and 6

4. Conclusions:

- Modelled thin sheet bending machine is simple and doesn't require so much of skill to operate. Hence un skilled labour can also operate this machine
- This machines cost shall be very low when compared to hydraulic and pneumatic sheet bending press. Hence micro and small-scale industries can easily afford this machine
- As this machines' size is small it can be accommodated in small space and transportation of this machine is very easy
- Maintenance cost of this machine is low due to simplicity in design
- This machine will be suitable for bending thin metallic sheets for Mild Steel and Copper are ranging from 0.1mm to 1mm and Aluminium is ranging from 0.1mm to 3mm as per conducted analysis results

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