DESIGN AND ANALYSIS OF MULTIFACE HYDRAULIC BENDING MACHINE DIE

A.G.DEEPAK NAARAYAN[1], M.ARULKUMARAN[2], R.KISHOREKUMAR[3], Mr. S.MURUGESAN[4]

[1,2,3] UG Scholar, [4] Assistant Professor
[1,2,3,4] Department of Mechanical Engineering,
Sengunthar Engineering College(Autonomous), Tiruchengode, Namakkal, India.

ABSTRACT: The project is about designing a bending die for a Hindustan Hydraulic Press Brake machine. The company is Craft Engineering, and it is located in Malumichampatty, Coimbatore. It has been assigned the project of designing and manufacturing tools. The old design was ineffective. The component formerly required a larger number of dies for bending in the production process. The production cycle time is increasing, which necessitates greater room. Various causes were identified and solutions were developed using data gathered from the industry during this research. Component, formatting, style, styling, and insert are all keywords.

1. INTRODUCTION

In most cases, a die is installed in the press brake during bending. This is a channel-like portion that is stationary. The bend that will be formed is defined by the outside shape of the die. With the use of clamps, a tool is mounted to the machine's ram and has rounded edges that produce the bend's interior shape. The bending force is created by the punch, which is a moving part. The tool descends, applying pressure to the sheet metal. When the pressure exceeds the plastic limit of the sheet metal, the sheet metal goes through a plastic deformation stage and takes the shape of the die beneath it. The punch then goes upwards for the next cycle once the process is completed. This is it.

2. MACHINE DIE METHOD

2.1. SHEET METAL BENDING

The process of bending a metal is termed as bending. Sheet metal, tubes, square hollow, rod, and iron angle are all options for the metal. This metal has a thickness of its own. Several factors are taken into account while building bending machines, including the type of metal, the type of roller bender (power or manual), and the size of the bending machine. The capacity of the bending machine that can bend a sheet metal or tube is usually the only variation between different types of bending machines.

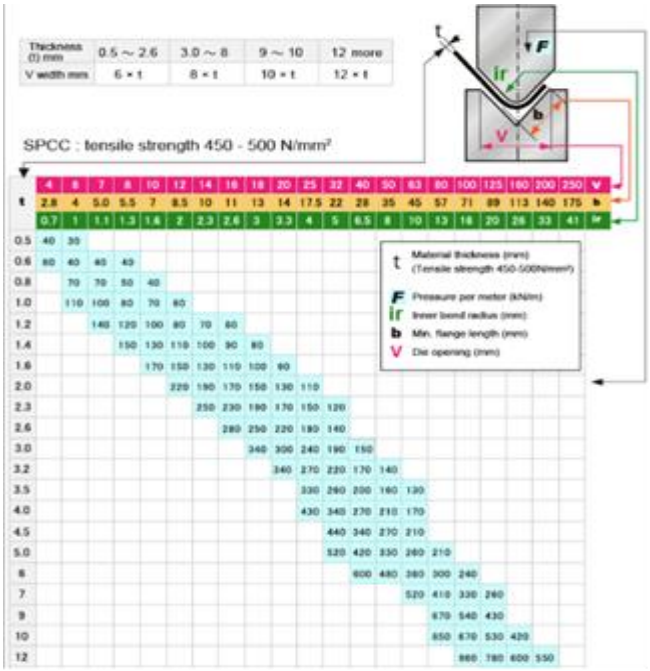
2.2. NEED OF AUTOMATION

The majority of the systems designed for bending dies necessitate the assistance of qualified and experienced die designers in making proper selections at various phases of process planning and die design. Most bending die design automation prototypes still suffer from the drawbacks of traditional expert system architecture and are unable to efficiently manage diverse information sources. Many studies have looked into using the finite element method (FEM) to optimise bending die design parameters. These methods, however, are impracticable for the planning and design stages of the deep drawing process due to the considerable calculation time and skill necessary to grasp the findings. Most sheet metal industries are currently experiencing a severe lack of experienced die designers. Furthermore, in the stamping industry, the mobility of experienced die designers has resulted in Sheet metal businesses all across the world are experiencing a great deal of difficulty.

2.3 V-BENDING

The most frequent punch and die bending method is V-bending. Bottoming, air bending, and coining are the three subgroups. Around 90% of all bending jobs are done with air bending and bottoming. According to the material thickness t, the table below can help you determine the minimum flange length b (mm) and inside radii ir (mm) (mm). You may also see the required die width V (mm) for such specs. A certain tonnage per meters is required for each process. This is depicted in the table

as well. As you can see, thicker materials and narrower interior radii necessitate higher tonnage. The highlighted options are metal bending standards that are recommended.



3. MATERIAL SELECTION

3.1 TOOL STEEL

They're usually exceedingly hard, wear-resistant, tough, and resistant to local overheating, and they're commonly manufactured to meet specific service requirements. Toughness, wear resistance, and heat resistance are the three. These three characteristics are built into the tool steel. Another quality of tool steel that is developed by the heat treatment process is hardness. Toughness refers to a steel's resistance to cracking, chipping, and breaking.

3.2. 42CrMo STEEL

It's a medium carbon alloy structural steel with excellent mechanical qualities, hardenability, and a wide range of applications. It's commonly utilised in the machinery industry to make gears, connecting rods, high-strength bolts, and other critical components. This is a particular high-strength steel that can be quenched and tempered.

3.3. 42CrMo MECHANICAL PROPERTIES

- Tensile Strength: no less than 1080 MPa.
- Yield Strength: no less than 930 MPa.
- Elongation: no less than 12%
- Rate of Reduction of Area: 45%
- Impact Absorbing Energy: no less than 63 J.
- Elastic modulus: 2.1e+11 N/m^2
- Poisson's ratio: 0.28
- Mass density: 7700 kg/m^3
- Shear modulus: 7.9e+10N/m^2
- Thermal expansion coefficient: 1.3e-05 /Kelvin

4. MACHINE CALCULATIONS

4.1. BENDING FORCE

$$BF = \frac{KL\sigma t(t)^2}{W} \text{ Newton}$$

K-Tensile strength

L-Bending length

K-Constant (K=1.33)

W-Die opening

t-Sheet thickness

Bending force for stainless steel metal

$$= \frac{1.33*50*600*(2)^2}{16} \text{ N}$$

BF =9975N

Bending force for aluminium sheet metal

$$= \frac{1.33*50*690*(2)^2}{16} \text{ N}$$

BF =11471N

4.2. BEND ALLOWANCE

$$BA = 2\pi \frac{A}{360} (R + K_{ba} t)$$

where BA = bend allowance; A = bend angle; R= bend radius; t = stock thickness; and Kba is factor to estimate stretching

If R < 2t, Kba = 0.33

If R ≥ 2t, Kba = 0.50

$$BA = 2*(22/7) * \frac{90}{360} * (R+0.33*2)$$

R=W/6

=1.6/6

R=0.27

BA=6.2857*0.25*0.93

Bending allowance =1.461

5. PROBLEM IDENDIFICATION

Since the dies come in different sizes, we'll have to determine which work we'll accomplish and manually place the die in the machine by workers. Also, because dies are heavy, two or three people are required to secure them in the die holder. Because the machine has so many dies, it requires additional storage space and material. For operation, more workers are required. It has more time to replace and calibrate the machine's measurements. Change the material to withstand the same load with less volume than the current type.

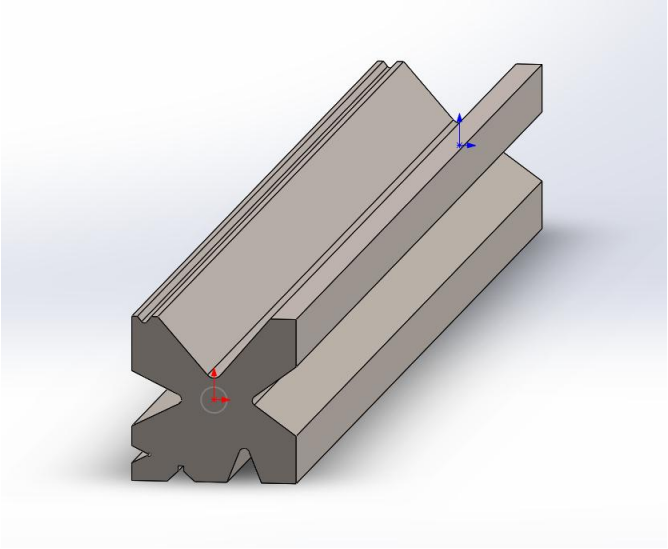
6. WORKING PRINCIPLE

Initially, the fundamental design is drawn and fed into the bending machine's electronic controller, where the drawing is converted into numerical control. The sheet metal bending value is also set in the controller. The hydraulic unit, sensors, and other drives in the machine are all controlled by the controller. Nowadays, dies come in many sizes and types, therefore a multi-face bending die is constructed and compared to an older one in order to endure the same capacity. The Multi-face hydraulic press brake bending machine die works by reducing the amount of material used in the fabrication, use, and selection of sheet metal bending errors. It is a die that combines four or five separate dice into one. This die is better suited to common bending machine operations. A press brake die is a tool which is used to produce sheet metal using a press brake. This tooling is made up of a variety of parts, and each tooling is made up of a different set of parts. It primarily accomplishes the processing of component shape by altering the physical condition of the produced material.

V-bending is the most popular method, in which the punch and die are "V" shaped. The punch bend the sheet by forcing it into the V-"V" die's shaped groove. "Air bending" occurs when the punch does not drive the sheet to the bottom of the die chamber, leaving space or air underneath. Bending tube and tube shaping requires the use of bend dies, clamp dies, and pressure dies. Each of these sorts of dies serves a certain purpose. Bending is done with a die and a punch. The bending is known as v-bending when a v-shaped die and punch are employed. Edge bending occurs when a sheet is bent on the edge using a wiping die.

7. INTRODUCTION OF FEM

In a variety of computer domains, the FEM is a mathematical model for predicting near experimental answers. Finite element analysis is the term given to numerical analysis based on FEM (FEA).



7.1. FEA WORKS

FEA could be used in engineering as a machine tool for performing arts engineering analysis. It involves using mesh construction techniques to break down a large problem into smaller components, as well as using a software package program that adheres to the FEM rule.

7.2. ADVANTAGES OF FEA SOFTWARE

- It decreases the number of prototype testing, saving both money and time; and it displays the results of the study in a graphical format.
- Finite element modelling and analysis are carried out in the pre-processor and solution phases, which would take a long time and, in some cases, be impossible to carry out manually.
- It aids in the optimization of a design.

7.3. PROCEDURE ANALYSIS

ANSYS is a finite element modelling software system that may be used to numerically solve a variety of mechanical issues. Among other things, it will perform structural (linear and non-linear), thermal, magnetic attraction, and fluid analysis. Analysis is made simple thanks to the user interface technique. The software system is given a graphical interface to make it easier to use.

The answer of a finite element analysis can be separated into three stages:

a. Pre-processing stages

b. Solution

c. Post processing

7.4. PRE-PROCESSING STAGE

The following major steps are engaged in the pre- processing stage:

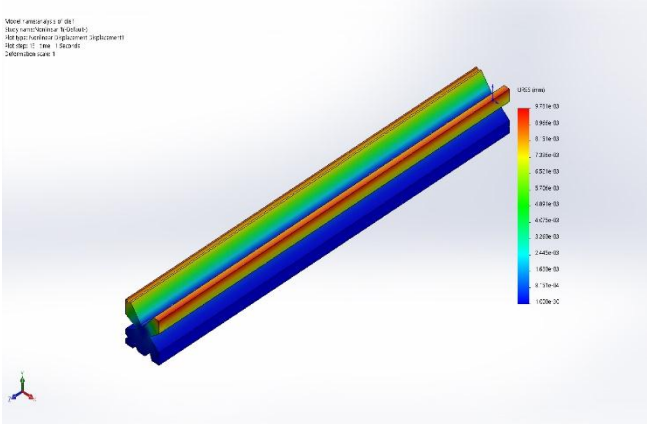
1. Import or Create geometry
2. Define element type & real constants
3. Define material properties
4. The meshing of lines/areas/volumes

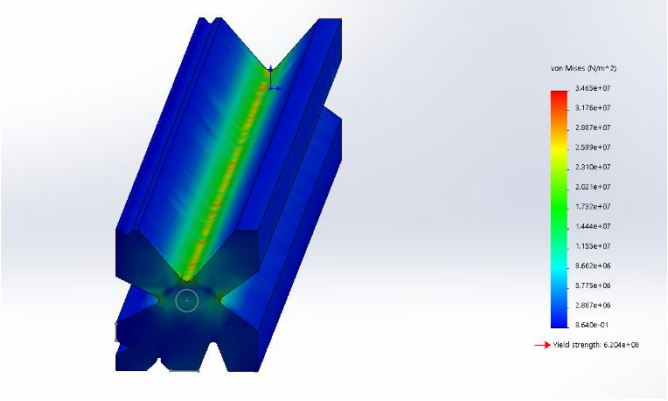
7.5. POST PROCESSING

- Examining the analysis findings to see how the applied loads affect our design is one of the most critical phases.
- With this post-processor, we can see temperature distribution and heat flux, among many other things.

8. RESULTS

NAME	TYPE	MIN	MAX
STAIN	ESTRN: EQUIVALENT STRAIN AT STEP	$983_{e-}08$ Element:2125	$1.048_{e-}04$ Element:9454
STRESS	VON: VON MISES STRESS AT STEP	8.640e-01 N/m^2 Node:11040	3.465e+07 N/m^2 Node: 450
DISPLACEMENT	RESULTANT DISPLACEMENT AT STEP	0.000e+00 mm Node: 889	9.781e-03 mm Node: 9279





8. CONCLUSIONS

We can see how crucial the bending die process is in the manufacturing industry. The objective of this thesis is to determine the stress and strain on the sheet as the tool presses it toward the die. A simple sheet design with piercing and shape forming features was considered. The deformation of all materials is the same after the simulation, however the stress of one material is larger than that of other materials with thickness. When comparing the same thickness with different materials, the influence on stress and strain is larger.

ACKNOWLEDGEMENT

The design and development of bending dies has been a fascinating subject for bending die research, encouraging one's mind to reach new heights in the mechanical engineering sector. Mr.sendhilvelan,B.E., our company's project guide, for his great assistance and sharing of his industrial expertise. This knowledge will constantly motivate us to complete our tasks flawlessly and professionally.

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