

# International Journal of Innovative Research in Science, Engineering and Technology

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## Develop Experimental Setup of Hydroforming to Reduce Wrinkle Formation

Pruthvi Patel <sup>1</sup>, Jahnvi Gaekwad <sup>2</sup>, Prem Patel <sup>3</sup>, Jaimil Gandhi <sup>4</sup>, Mitesh Patel <sup>5</sup>

Student, Department of Mechanical Engineering, K.J. Institute of Engineering & Technology College, Savli,  
Gujarat, India<sup>1,2,3,4</sup>

Assistant Professor, Department of Mechanical Engineering, K.J. Institute of Engineering & Technology College, Savli,  
Gujarat, India<sup>5</sup>

**ABSTRACT:** Sheet hydroforming is a process that uses fluid pressure for deformation of a blank into a die cavity of desired shape. This process has high potential to manufacture complex auto body parts and other sheet metal parts. This process is very useful for light weight material including low carbon/ mild steel for chassis and side rails, aluminium and its alloy for automotive body, stainless steel for exhaust system parts. Experimental setup has been developed to investigate the process parameter and some experimental studies have been conducted on materials like aluminium and copper by varying sheet thickness and also considering different fluid pressure value. Purpose of the study is to investigate the effect of selected process parameters like material type, thickness and fluid pressure on wrinkle formation. The experimental investigation also indicates that as the fluid pressure increases wrinkle formation reduces irrespective of material type and thickness variation.

**KEYWORDS:** Forming, Hydroforming, Sheet Metal Hydroforming, Wrinkle Formation.

### I. INTRODUCTION

Forming is the manufacturing method for deforming the ductile material into desired shape without material wastage. In forming process induced stress is beyond the yield strength but less than the ultimate strength.

Various types of forming process are bending, curling, deep drawing, expanding, hydroforming, punching, roll forming, stamping, spinning, stretch forming, rubber pad forming, explosive forming, electro-magnetic forming, etc.

**Hydro-forming Process:** - It is also known as fluid forming. Forming pressure is applied by the action of hydraulic fluid against a flexible membrane, which forces the blank to assume the shape of the rigid tool.

Hydro-forming is a non-conventional forming process. It deforms the blank into cavity using high pressurized non compressible fluid instead of hard tool. This process is very useful for light weight ductile material i.e. aluminium and its alloy for automobile body, stainless steel for exhaust system and carbon or mild steel for chassis.

It is similar to conventional deep drawing process. It has significant advantages for formed parts which are less work, inexpensive, durability of material, functional, quick setup, save money and no need to waste time thinning material out. Also it keeps tooling cost and production cost low. Sheet Hydro forming is a process which uses high pressure fluid for deformation of a blank (sheet) into a desired shape with die. This process has high potential to manufacture complex auto-mobile parts and other sheet metal parts.

Sheet Hydro forming technology is very useful for of complex part having high strength to low weight ratio for auto body parts and aerospace industries. It offers many advantages over conventional forming such as tooling cost, waste of material, joint free component, with better surface finish and low tolerance. Purposes of this study to improve the competitiveness of sheet hydro forming by reducing the initial investment cost increase the production rate of auto body parts as well as eliminate the drawbacks like thinning, spring back and wrinkle formation. Proposed methodology for the present study has to develop the experimental setup for sheet hydro forming process.

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## II. RELATED WORK

Bharatkumar Modi (2012) has design and developed experimental hydro forming set up to deform the square cup of AA5182 alloy. Experimental work carried to achieved minimum corner radius and thinning by variable blank holding force. They have used finite element analyses for the validation of experimental results and represent good agreement among them <sup>[1]</sup>.G. Palumbo (2012) has carried out experiments on aluminium automotive component on innovative setup and shows some results of their research. Main aim of that study was to analyse the effect of process parameter (closing force and pressure) on defects and fracture. Finite element simulation methodology was carried for critical strain value. They have prepared specimens for decrease material thinning in the critical region <sup>[5]</sup>.F. Djavanroodi (2010) has been investigated experimentally formability of high strength sheet metal Ti6Al4V titanium and Al6061-T6 aluminium alloys. Hydro mechanical deep drawing setup has assisted by floating disc. Thickness, the yield and tensile strength, strain-hardening and strain-rate sensitivity have effects on forming limit diagram obtained experimentally<sup>[4]</sup>.Nader Abedrabbo et al. (2005) was performed experimental work for the elimination of wrinkle and tear formation in sheet hydro forming process for deep-drawn hemispherical cup AA6111-T4 aluminium alloyBased on the finite element model they establish the input parameter for find out the optimum fluid pressure that eliminate the wrinkle and tear. An end result of that experiment shows that wrinkle in flange and die corner area was generated due to pressure loss by pressure regulator/controller <sup>[3]</sup>.S.H. Zhang (1997) has represented hydro mechanical deep drawing features in process parameters in theory and in numerical simulation. They have presented detailed progress information about process principles and process features and related development <sup>[6]</sup>.Ch. Hartl (2005) provides the information about lots of work was carried in the research and development of hydro forming technology by providing the funds and facilities by industries, supplier and user. How the heat energy has contribute in hydro forming technology for the various applications <sup>[2]</sup>.

## III. DEVELOPMENT OF EXPERIMENTAL SETUP

Based on the literature review present work is concentrated on development of experimental setup for sheet hydro forming process. The sheet blank is place between the blank holders and fixed into the die assembly. Electrical motor driven pump supply's the high pressure hydraulic oil from storage tank to fluid container of the die assembly and strikes on the sheet blank. Pressure is controlled by the pressure regulator and supplies into die assembly by the direction control valve. The desired pressured is shown in the pressure gauge. This high pressure oil starts the deformation of the sheet blank against the die and maintains the pressure in few second. Then relief valve reduce the pressure up to zero and wrinkle formation on surface of product is inspected. In view of all the considerations discussed above, the scheme of proposed setup has been shown in Fig1.

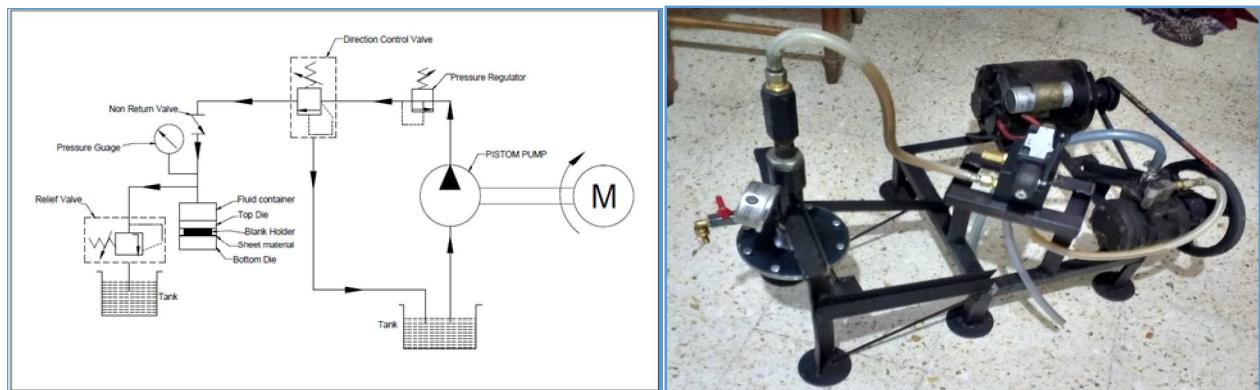


Fig.1 Experimental Setup for Hydro Forming

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## IV. EXPERIMENTAL RESULT

Experiments have been done on 0.5mm, 0.7mm, 0.9mm thickness aluminium and copper sheet at 5kg/cm<sup>2</sup>, 7kg/cm<sup>2</sup>, 10kg/cm<sup>2</sup> fluid pressure.

Table 1. Experimental results of Aluminium & Copper for Different fluid pressure and thickness

Serial no	Material	Thickness (mm)	Fluid pressure (kg/cm <sup>2</sup> )	Dome Height (mm)
1	Aluminium	0.5	5	5.98
2	Aluminium	0.7	5	5.76
3	Aluminium	0.9	5	3.58
4	Aluminium	0.5	7	6.18
5	Aluminium	0.7	7	6.18
6	Aluminium	0.9	7	4.00
7	Aluminium	0.5	10	8.86
8	Aluminium	0.7	10	8.32
9	Aluminium	0.9	10	5.48
10	Copper	0.5	5	3.58
11	Copper	0.7	5	3.42
12	Copper	0.9	5	2.44
13	Copper	0.5	7	3.60
14	Copper	0.7	7	3.55
15	Copper	0.9	7	2.68
16	Copper	0.5	10	5.20
17	Copper	0.7	10	3.76
18	Copper	0.9	10	3.32

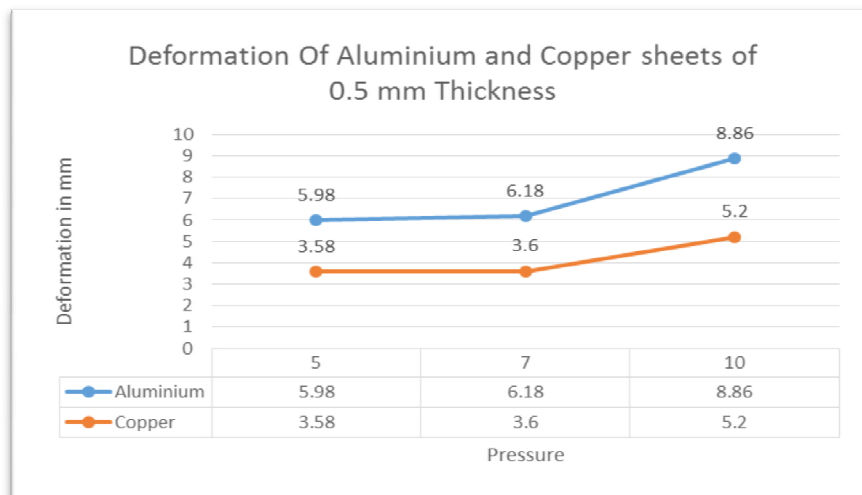


Fig. 2 Aluminium & copper sheet of 0.5mm thickness

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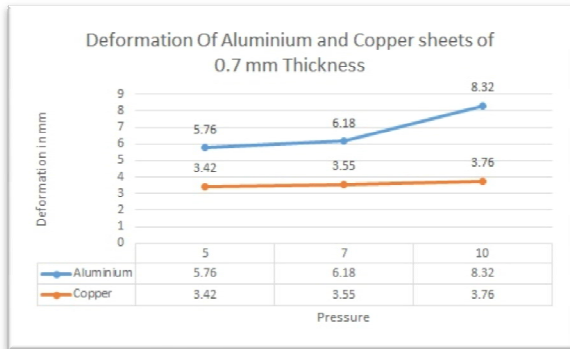


Fig. 3 Aluminium & Copper sheets of 0.7mm Thickness

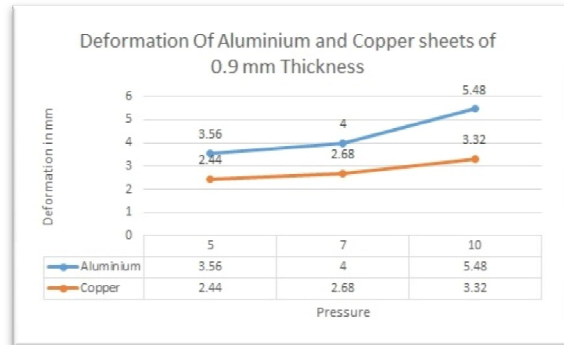


Fig. 4 Aluminium & Copper sheets of 0.9mm Thickness

From the experimental setup of hydroforming we see the Pressure versus Deformation graph of 0.5mm, 0.7mm, 0.9mm thickness of Aluminium and copper material and from the graphs we concluded that as we increased the pressure it will also increase the deformation of the material in Aluminium as well as copper both.



Fig. 5 Photographic view of 0.5mm thick sheet of aluminum and copper





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Fig. 6 Photographic view of 0.7mm thick sheet of aluminium and copper

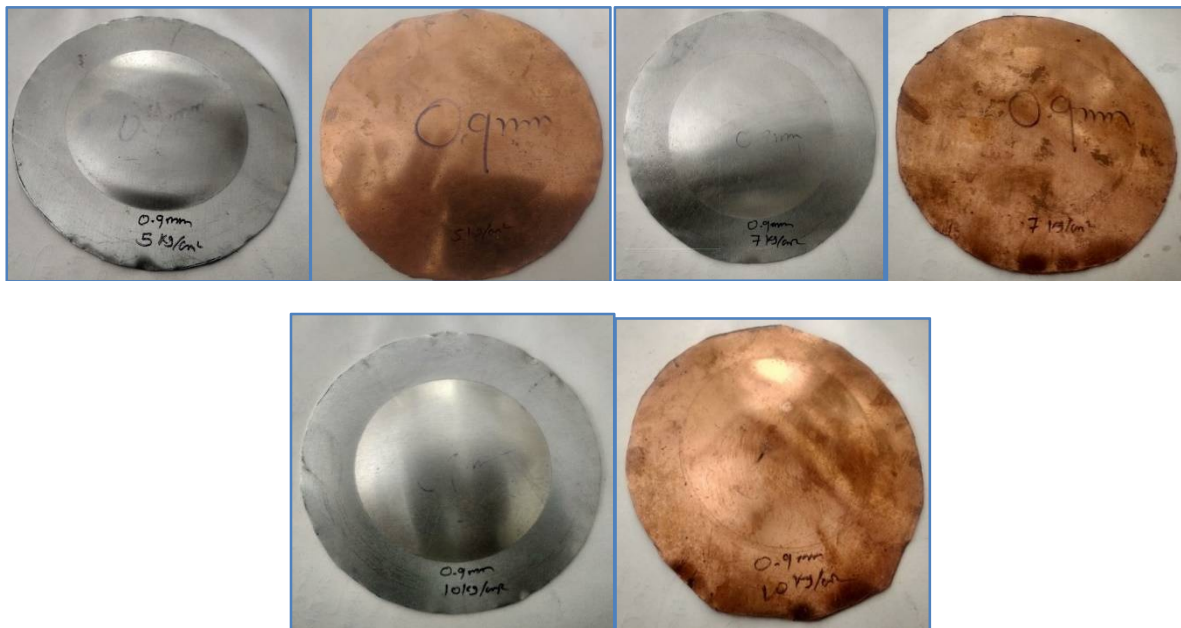


Fig. 7 Photographic view of 0.9mm thick sheet of aluminium and copper

### V. CONCLUSION

The experimental setup for sheet hydroforming is fabricated. The experiments are performed for copper and aluminium sheet to investigate the effect of sheet thickness and fluid pressure on wrinkle formation. A total of experiments are performed considering variations in sheet thickness and fluid pressure for each material. The experimental investigations also investigate that as the fluid pressure increases the wrinkle formation reduces irrespective of material type and thickness variation.

In future, the effect of variable blank holding force on wrinkle formation can be measured. Also 'Limit Drawing Ratio' can be determined. Validation of experimental results can be possible using Simulation Software.

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