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A Review on Incremental Forming Process of Two Dissimilar Materials

Absar Malek[1], MR. Ripal Patel[2]

[1]M.E. Scholar, Production Engineering, S.N.P.I.T&R.C. Umrakh, Gujarat, India
[2]Professor, Dept. of Mechanical Engineering, S.N.P.I.T&R.C. Umrakh, Gujarat, India

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Abstract-*Incremental sheet metal forming is suitable for small batch production of sheet metal forming parts and formability is the key property for any forming process. Incremental forming is highly flexible and versatile process for manufacturing of complex sheet metal parts. Different material combinations are advisable for better outcome in formability increment during incremental forming process. Process parameters like spindle RPM, Feed rate, Step depth is having adequate effect on formability of two dissimilar materials.*

Key words: **Formability, Dissimilar materials, ISF, Process parameters**

1. INTRODUCTION

Incremental sheet metal forming is highly flexible and versatile process for the manufacturing of different sheet metal parts. Incremental forming is a technology that allows producing highly customized products using Computer Numerical Control (CNC) machines. Incremental sheet forming (ISF) is a flexible forming process for small batch manufacturing as well as rapid prototyping of arbitrary 3D shapes. In ISF, a clamped sheet metal is progressively formed by a moving forming tool by CNC machines. In ISF, compared to conventional sheet metal forming processes such as deep drawing, only a single die is needed, which does not have to be a full die but can be a partial support. The tool path covers the surface of the desired product through CNC control, similar to the finishing stage in machining. In every instant of the forming process in which the tool moves over the sheet metal, localized plastic deformation is produced and the final shape of part is the result of all localized plastic deformation.

2. WORKING PRINCIPLE

In ISF, the sheet metal to be formed (blank) is fixed in a rectangular support, which is independent of the final shape of the sheet. The main function of this rectangular support is to control the movement in vertical direction in Z-axis of a CNC machine. When the forming process is carried out this fixation prevent the sheet from movement, thus creating a plastic deformation in sheet. A tool starts ISF process by means of continuous movement on surface of plate and by gradually increment in vertical direction, carries out the forming. The product of this process can made directly from a CAD model of finished product without making of die. The main difference of ISF process is very much beneficial to small production volumes and fast manufacturing of sheet metal components.

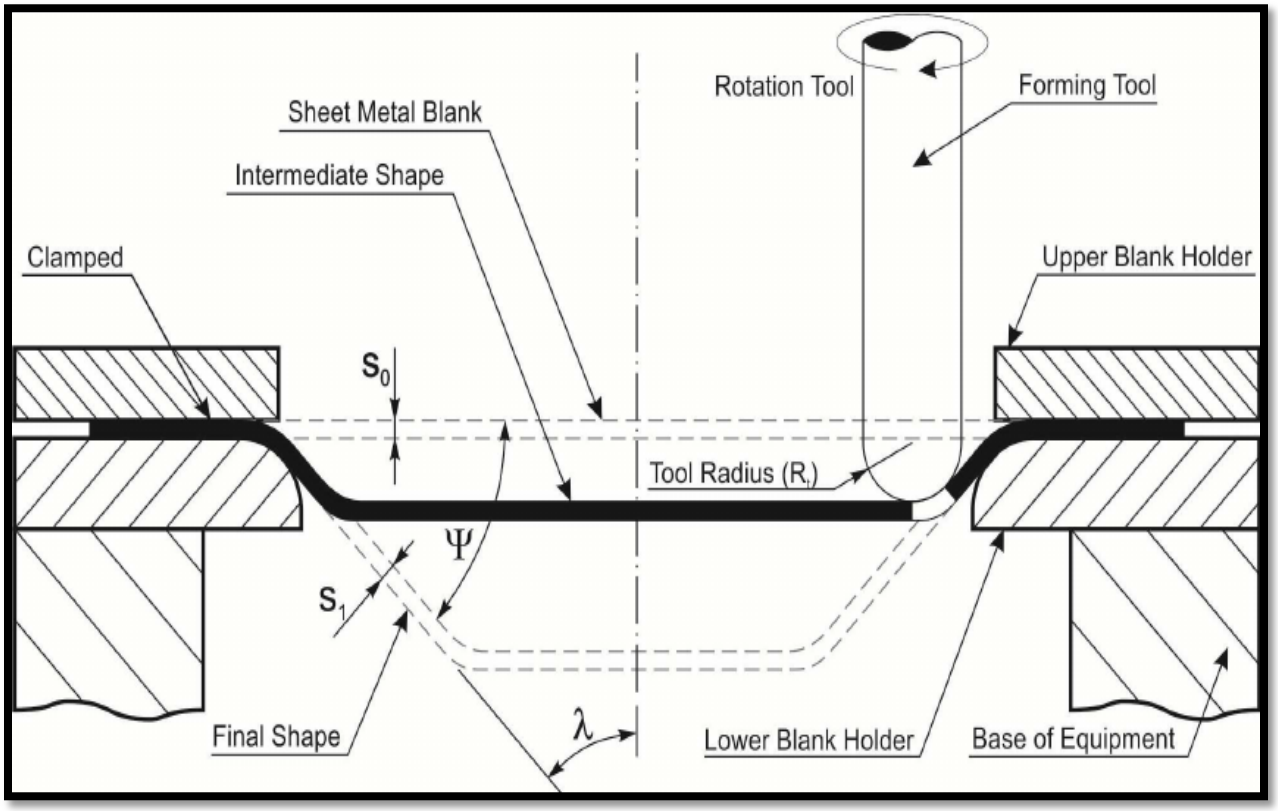

Figure 2.1 Principle of ISF[21]

3. WORK PIECE MATERIAL

Many different materials examine for the formability checking and conclude that two different materials have potential for great formability in forming process. Combination of two different materials can results in increase in formability as well as strength in incremental forming process. Al-Cu bimetal is having great advantages like light weight, strength, corrosion resistance etc so forming of particular this combination is very important in forming industry. This is most important combination among all alloys due to its use in various applications. This combination of two dissimilar materials can resist high pressure and temperature, making it suitable for high performance applications. Aluminum also has great formability and strength which is essential for this incremental forming process.

4. Tool material

Tool material plays important role in incremental forming process. The main criteria for selection of tool material depend on the work piece material. Tool material is slightly harder than work piece material so that forming of work piece can be done effectively. For Al-Cu bimetal generally WPS material is use with hardening of 50HRC. Generally for particular incremental forming process there is no specific requirement regarding tool is require because in this forming process there is no cutting or machining is carried out. Just desire shape can be obtained by continuous rotation and motion of tool is essential for efficient forming of work piece material.

5. PROCESS PARAMETERS

The main process parameters that affect the incremental forming process are feed rate, step depth, tool rotation speed and tool diameter and tool shape. These process parameters affect the forming process according to accuracy in terms of surface finish and dimensional accuracy.

5.1 Feed rate

Feed rate is very essential and important process parameter in incremental forming process. Feed rate can be termed as the speed with which the tool is travelling according to program given by CNC part programming. This speed affects the surface quality and it is very important in incremental forming process. As incremental forming is applicable in highly precise parts manufacturing feed rate is termed as very important during forming process. Higher feed rate can save time but it will compromise surface quality so optimize feed rate is best option during incremental forming process. Low feed rate can improve formability.

5.2 Step depth

Step depth can be termed as the depth with which tool moves inside the work piece material per revolution or per one cycle of desire shape. In simple meaning after completion of one succeeding cycle of tool movement in desire shape tool moves inside work piece material to form desire shape. The amount which tool moves inside material is called as step depth. This depth plays important role as it directly affect the dimensional accuracy. Higher step depth can change the desire shape and fail whole forming process. Formability can increase with decrease in step depth and higher step depth results in decrease in formability.

5.2 Tool rotation speed

Tool rotation speed is important process parameter as it affects the dimensional accuracy of desire shape during incremental forming process. The speed with which tool rotates during forming process according to CNC part programming to obtain desire shape is said as tool rotation speed. At high tool rotation speed the end result of forming shape is effective and desirable. Thickness distribution and grain size distribution of formed part are depends on the tool rotation speed. Friction at tool and sheet interface can improve formability and it is depends on tool rotation speed.

5.4 Tool diameter and tool shape

Tool diameter and tool shape is depends on the part shape and size. Generally tool with ball shape end, hemispherical end tool, pointed tool are use in incremental forming process. In comparison to tool shape ball tool is more effective than hemispherical end tool during incremental forming process. Tool size as well as tool diameter influences geometric accuracy.

6.CONCLUSION

Formability in two different materials is different according to layer arrangement as well as two different materials combination can improve formability as well as strength. Combination of two different materials made by Friction stir welding is capable of manufacturing complex sheet metal parts with the help of Incremental forming process. Higher tool rotation speed and less feed rate can improve formability. Step depth, feed rate, tool rotation speed and tool diameter are most effective parameters for incremental forming process of two dissimilar materials.

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