SIMULATION AND EXPERIMENTAL VALIDATION OF EN 19 FORGED CRANKSHAFT FOR SURFACE CRACK IN CLOSE DIE FORGING

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Abstract

The manufacturing process of Crankshaft is studied. Defects found in crank shaft are surface cracks, unfilling, scale pits and lap. Surface Crack is contributed more toward rejection. To reduce surface crack, simulation is to be carried out in FEM based software DEFORM 3D, to visualize the material flow in die cavity. Temperature range is to be found during simulation in DEFORM 3D, Experiments are to be carried out at temperature range to validate DEFORM 3D result .

Keywords*: Surface Crack Defect, Deform 3D, Simulation, Temperature Range*

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1. INTRODUCTION

Forging is the process by which the metal are shaped by using localized compressive forces. It is commonly done either by hot or cold forging. After forging we get parts of superior mechanical properties with minimum waste of material. Forging is the process by which the materials having simple geometry are deformed by compressive forces to complex configuration product/parts . Parts manufactured by forging process have more strong and compact structure than casted parts. To achieve improved grain structure, physical and mechanical properties of the metal we usually use close die process.

1.1 Open die Forging : In open die forging, flat dies are used to deform in lateral direction by applying force. We can classify open die forging into cogging, fullering and edging. Fullering and Edging operations are done to minimize the cross section using convex shaped or concave shaped dies. Material gets distributed and hence gets elongated and reduction in thickness.

1.2 Closed Die Forging: It is a process of shaping of hot metal completely within the walls or cavities of two dies that come together to enclose the work piece. The impression for the forging can be entirely in either die or can be divided between the top and bottom dies. The material used is generally round or square bar. These bars are cut to length to provide the volume of metal needed to fill the die cavities in the addition to an allowance for flash and sometimes for a projection for holding the forging. The flash allowance is in effect a relief valve for the extreme pressure produced in closed dies. Flash is also acts as a brake to slow the outward flow of metal in order to permit complete filling of the desired configuration.

2.DEFORM 3D SOFTWARE

This research begins with the modelling of the dies in the 3D modelling software NX. The modelled drawings are then imported in .STL format in DEFORM 3D software.[2]. Fig 2.1 shows the methodology of DEFORM 3D Software.

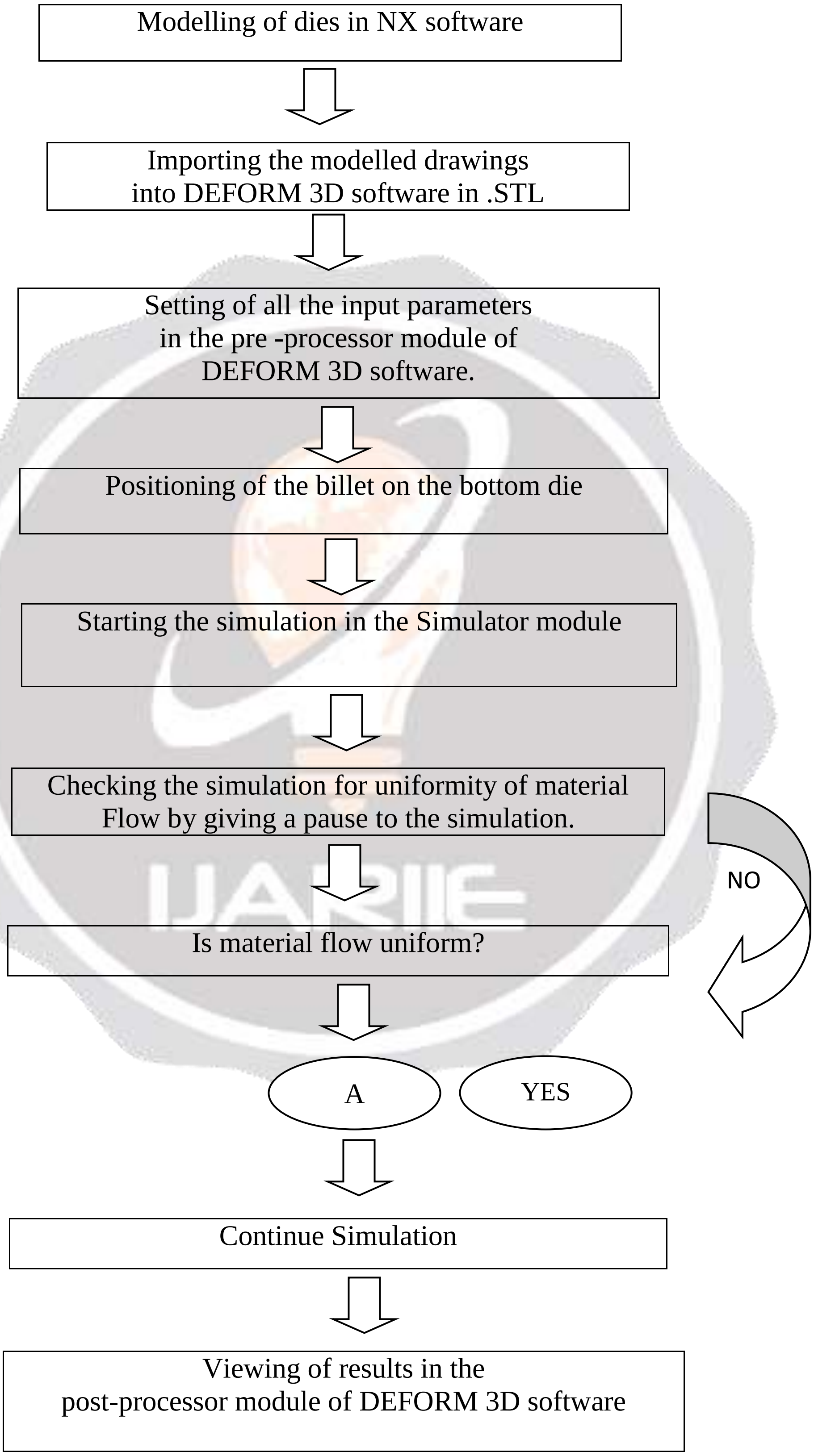

Fig 2.1 Methodology of Deform 3D software [2]

3. SIMULATION OF CRANK SHAFT

Simulation is carried out at different temperature to find out temperature range were no surface crack is found.
Simulation result are as follows:

Fig 3.1 shows the simulation of work piece temperature at 1270^{0}C

Fig 3.2 shows the simulation of work piece temperature at 1260^{0}C

Fig 3.3 shows the simulation of work piece temperature at 1230^{0}C

Fig 3.4 shows the simulation of work piece temperature at 1200^{0}C

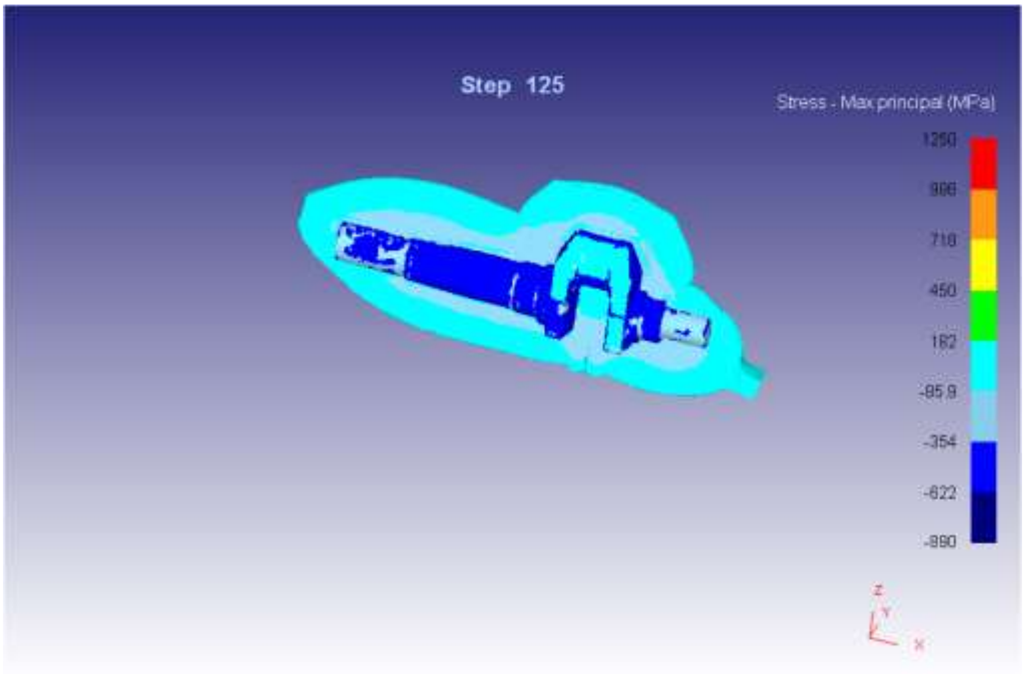

Fig 3.1 Simulation of work piece temperature at 1270 ^{o}C

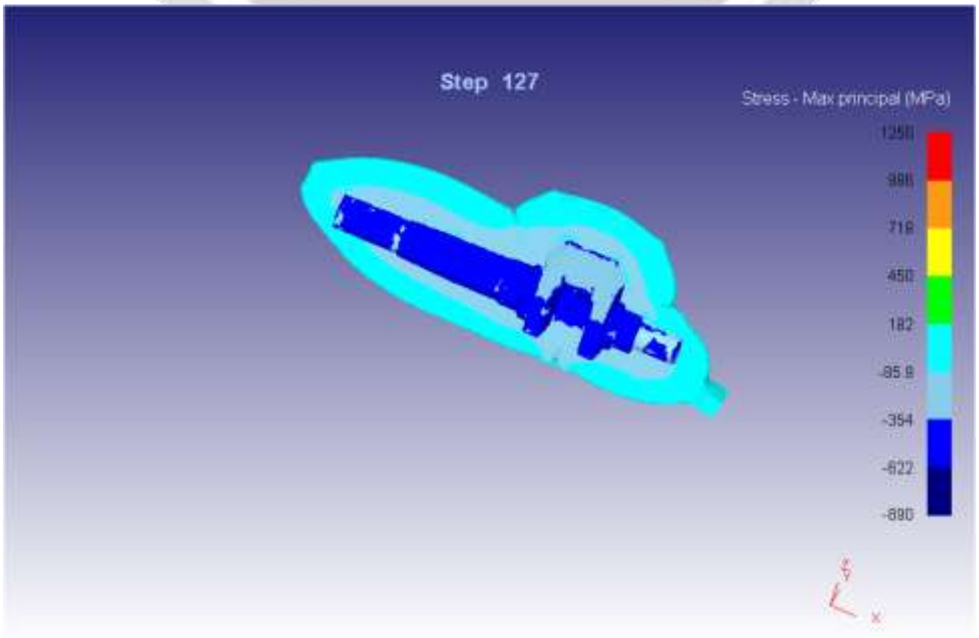

Fig 3.2 Simulation of work piece temperature at 1260 ^{o}C

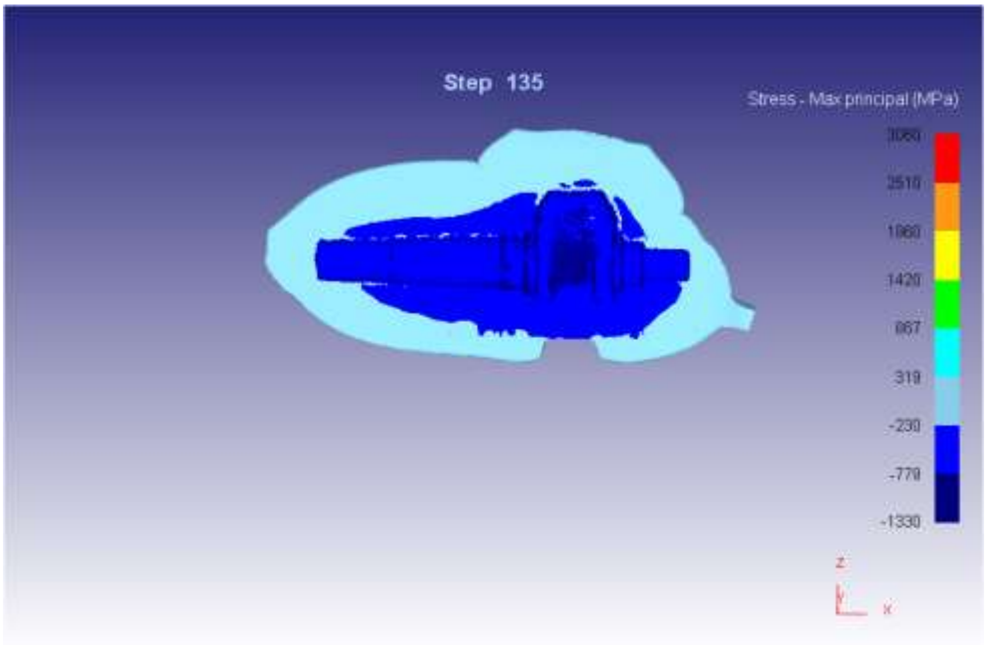

Fig 3.3 Simulation of work piece temperature at 1230 ^{o}C

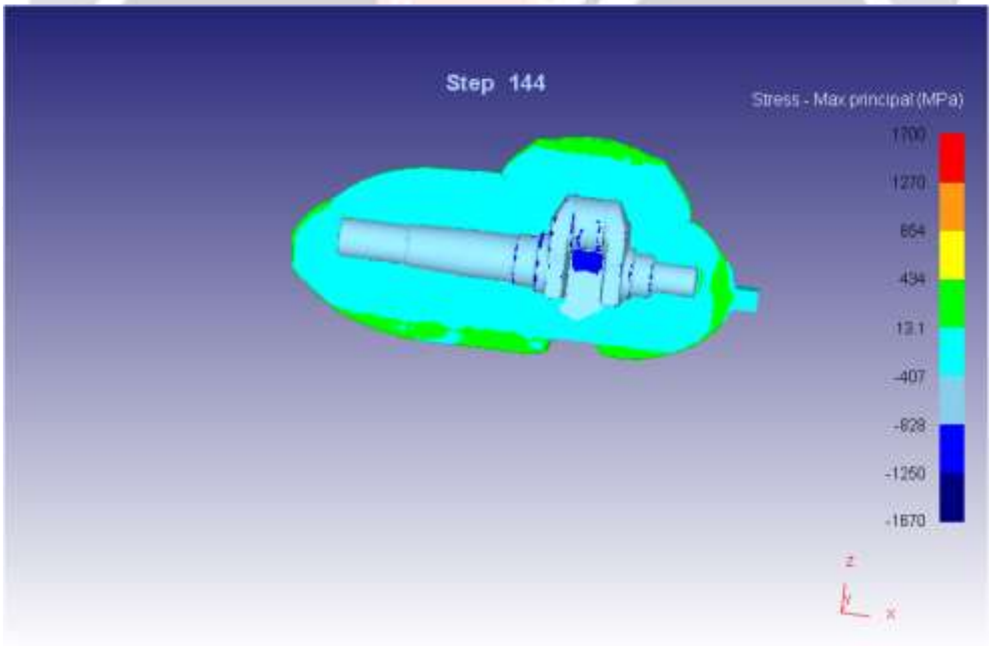

Fig 3.4 Simulation of work piece temperature at 1200 ^{o}C

TABLE 1.1: Simulation Results

Different Temperature Range	Max Stress (MPa)
1. 1270^{0} C	-85.9 to 182
2. 1260^{0} C	-354 to -85.9
3. 1230^{0} C	-778 to -230
4. 1200 ^{0} C	-828 to -407

Table 1.1 show simulation result of different 4 temperatures

Simulation was performed at four different temperatures such as 1270°C, 1260°C, 1230°C, 1200°C. Result from the simulation it is concluded that 1200^0C-1230^0C is optimum temperature range where no surface crack is found.

But drop in temperature after rolling process is nearly 20^0C so optimum temperature range where experiment are to be carried to be 1220-1250^0C.

Temperature range: 1220°C to 1250 °C.

4. EXPERIMENT FOR VALIDATION OF SIMULATION RESULT

After finding the temperature range from the simulation , it is necessary to validate the result of simulation so 16 experiment at different 16 temperatures are to be carried out.

Step 1 : Rods to be cut in proper size of billet by using band saw machine in 75×75mm.

Step2: Heating billets at different 16 temperatures in oil fired gas furnace and measuring temperature using pyrometer.

Step3: Carrying out two step forging process i.e Rolling and Finishing.

Step4: After forging final inspection i.e Visual inspection.

Result: Whether Surface crack found or not.

Table 1.2 shows the experiment at 16 different temperatures.

Table 1.2 Experiment at Different Temperatures

Temperature (°C)	Result (after inspection)
1220 ^{0}C	No Surface Crack found
1222 ^{0}C	No Surface Crack found
1224 ^{0}C	No Surface Crack found
1226 ^{0}C	No Surface Crack found
1228 ^{0}C	No Surface Crack found
1230 ^{0}C	No Surface Crack found
1232 ^{0}C	No Surface Crack found
1234 ^{0}C	No Surface Crack found
1236 ^{0}C	No Surface Crack found
1238 ^{0}C	No Surface Crack found
1240 ^{0}C	No Surface Crack found
1242 ^{0}C	No Surface Crack found
1244 ^{0}C	No Surface Crack found
1246 ^{0}C	No Surface crack found
1248 ^{0}C	No Surface crack found
1250 ^{0}C	Surface crack found

5. CONCLUSION:

From the experiment result it is concluded that no surface crack defect was found at different 15 temperatures where experiments were carried out. But at 1250^0 C temperature surface crack was found. Thus experimental result are the validation of the simulation result. Results were found quite satisfactorily for company. It is very beneficial to the company in reduction of the surface crack defect in crankshaft made from close die forging.

6. REFERENCES

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