

**Analytically Analysis Related To Stress Concentration on Casting Material of
Flange**Rana Rafikmahammad Pyarasaheb¹, Kayastha Krunal Suryakant², Parmar Ashwin Babubhai³, Nakum Magan Bavbhai⁴¹Mechanical Department, Lecturer, Parul University,²Mechanical Department, Asst. Professor, Parul University³Mechanical Department, Lecturer, Parul University⁴Mechanical Department, Lecturer, Parul University

Abstract- Defect arises in the part of flange shaft (casting) made of material GS42crMo4. After castings were made, they were inspected in inspection department by visual test and non-destructive test. If casting has minor defect then it could be repaired. If defect was major then it could not be repaired and casting was rejected. In one particular casting (the part of flange shaft) the crack was observed at the head, on radius portion, which was major defect. Due to heavy thickness section at the head side, the smaller radius may shrink. Crack was observed after final machining on radius portion. It was a blind crack inside the casting product, and it was invisible before machining. It was due to the stress concentration at the radius portion. So, it could not be repaired by grinding and welding. Due to this major defect the casting was rejected.

We change the design at the radius portion; because defect was occur at the head of the casting on the radius portion. In the defective design there were two small radii at the head portion, where stress concentration was more, so there was a possibility of occurring crack.

Then we change the design by making one big radius instead of two small radiuses, & stress concentration at the head portion was decreased and so we minimized defect of casting flange.

Keywords- Casting Part, Stress Concentration, Kt Factor, Machining process, Cracks, Material GS42crMo4, Numerical Analysis

I. INTRODUCTION

A stress concentration (often called stress raisers or stress risers) is a location in an object where stress is concentrated. An object is strongest when force is evenly distributed over its area, so a reduction in area, e.g. caused by a crack, results in a localized increase in stress. A material can fail, via a propagating crack, when a concentrated stress exceeds the material's theoretical cohesive strength. The real fracture strength of a material is always lower than the theoretical value because most materials contain small cracks or contaminants (especially foreign particles) that concentrate stress. Fatigue cracks always start at stress raisers, so removing such defects increases the fatigue strength.

Any physical discontinuity in a structural member or a sudden change in the geometric form of a part leads to a region of stress concentration. The abrupt change in cross sections cause the stress "flow lines" to crowd causing high stress concentration. To mitigate this phenomenon, smoother changes such as fillet radii are introduced in structural members that make the "flow lines" less crowded causing lower stress concentrations.

II. LITERATURE REVIEW

Kulkarni et al. (1992) developed an expert system that could analyze casting defects in steel castings. This defect analysis expert system was user friendly and asks a sequence of questions that require a "yes" or "no" answer. Eventually, the expert system would draw a conclusion stating the nature of defect. It then lists all possible causes and remedies for the defect. During the interrogation process, if the program reaches a dead-end and no conclusion can be made, it may then be presumed that the nature and complexity of the defect is beyond the knowledge of the expert system. After the human expert determines the cause of this new defect, this new knowledge can be added to the knowledge base of the expert system. However, the knowledge domain of this expert system includes only the area of green sand moulding for steel castings.

Jagtap S.P. et. al. (2013) titled as "Stress Concentration And Failure Analysis Of Double Notched Composite Panel" done experiment & numerical study. In this paper the phenomenon of stress concentration factor is studied for the double notched glass – polyester composite panel subjected to the compressive loading; with the help of experimental stress analysis technique and the popular FEM technique. In this paper the experimental and numerical studies were conducted to investigate the stress concentration around a cut out in composite panel. The results obtained for the maximum stress and stress concentration factor using ESA technique are about 15 to 20 percent lower than obtained with the help of FEM technique but are within the acceptable limit.

R. Nagendra Babu et al. (2010) titled as “Prediction of stress concentration effect under thermal and dynamic loads in a high pressure turbine rotor” was numerical analysis done. They analyses the effect of stress concentration under thermal and dynamic loads in a steam turbine rotor grooves under the operating conditions. Stresses due to thermal and dynamic loads in high pressure steam turbine rotor of 210 MW power stations were found in two stages. A source code is developed for calculating the nominal stress at each groove section of HPT rotor. Maximum stress is obtained using FEA at the corresponding section. Stress concentration factors due to thermal and dynamic loads at each section were calculated. they observed that the stress concentration due to the combined effect of thermal and dynamic loads is exceeding the safe limits at temperatures beyond 540°C.

III. DETAIL DESCRIPTION OF PROBLEM

When customer give order for casting, firstly make design for that casting. Then the copy of design drawing is sent to the all department-pattern dept., molding dept., melting dept., fettling dept., inspection department. Pattern is prepared by pattern department and this pattern is given to the molding dept. to prepare a mold. The design of one particular casting, which is a part of flange shaft, is prepared by design department is shown below.

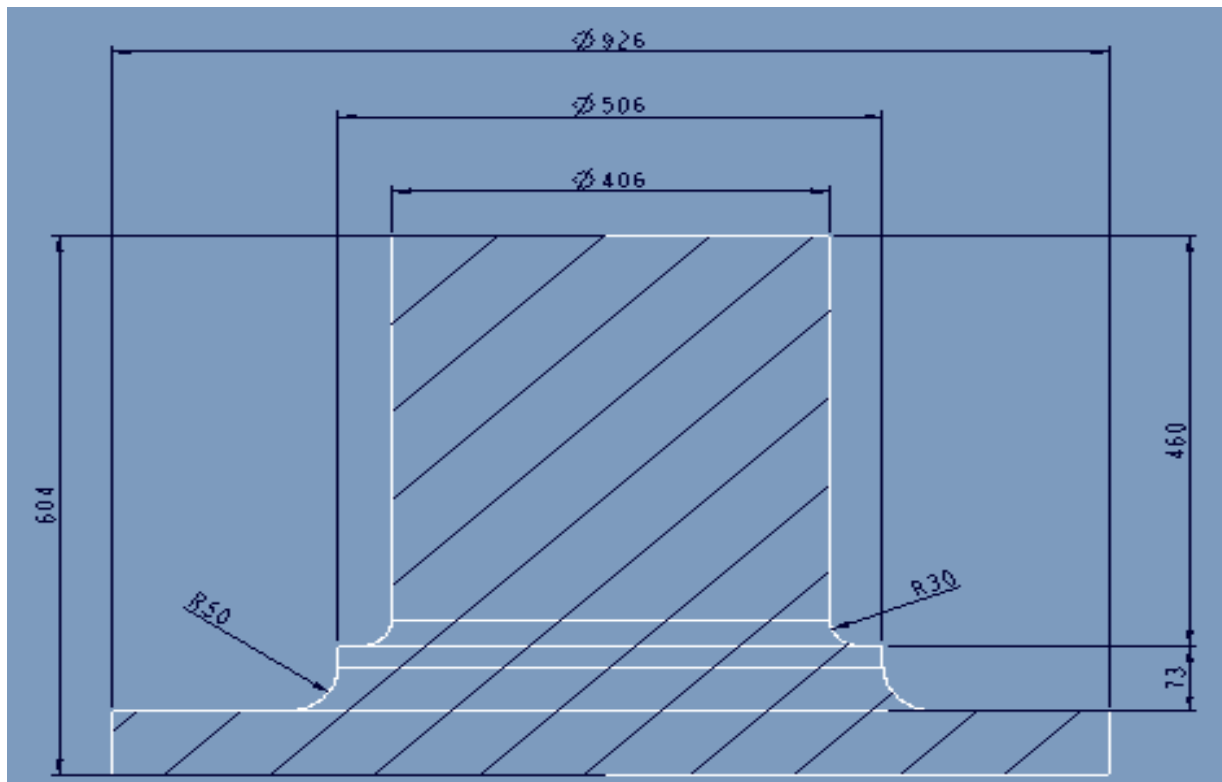


Figure 1: Design of the casting product (a part of flange shaft, $r_1=30\text{mm}$ & $r_2=50\text{mm}$)

Now this drawing is send to the pattern department. As per drawing they prepare a pattern and send to the moulding department. In the moulding department sand mould is prepared from pattern. The metal is melt down in melting department as per customer requirement. Then molten metal is pouring into the mould. After some fixed time the casting is knock out from the mould on vibrating machine. This casting has raiser, blow, and some extra metal. This knock out casting is send to the fettling department for removing raiser, blow, and extra metal. Then it is sent for the heat treatment as per customer requirement of hardening. The casting (the part of flange shaft) is shown below,

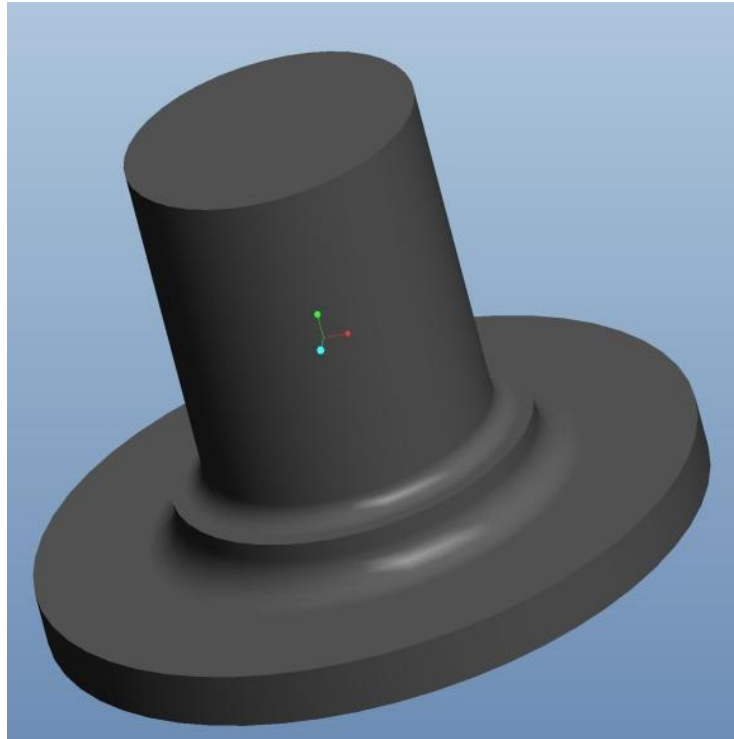


Figure 2: Casting product under study

The crack is observed on radius portion of the casting product, that portion is shown below:



Figure 3: The defect in the product shown by testing

The crack was occurs due to stress concentration at the radius portion. So this casting was rejected after final machining. Then we change the method for preparing this particular casting for eliminates the stress concentration.

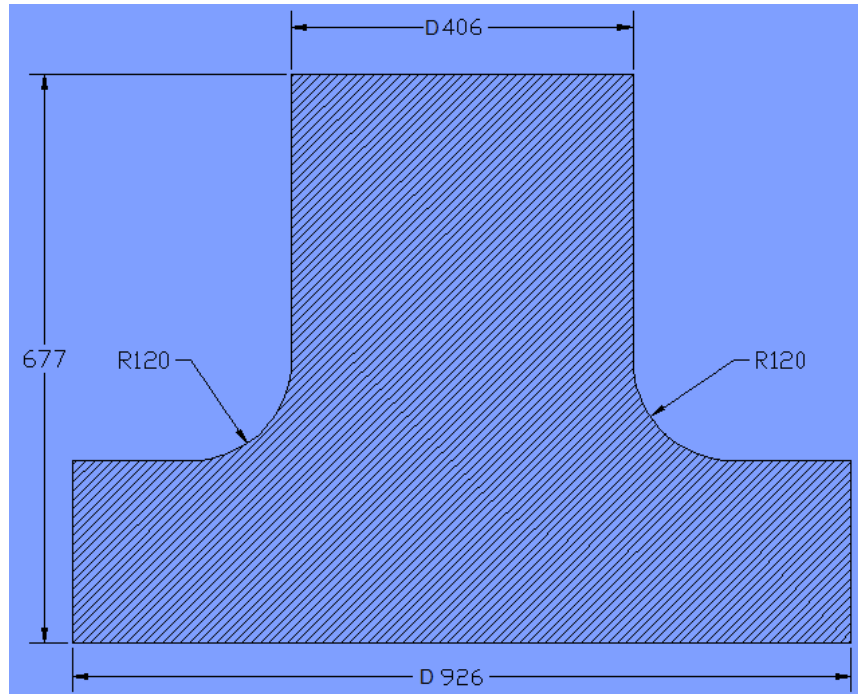


Figure 4: New Design for casting material of flange

The defect was occurring on the radius portion of the casting so by changing the design of the casting at the radius portion a defect free casting can be achieved. By using the design consideration and rule of the casting we change the design of the casting product, so we got casting without defect and it was able to perform its work properly.

The riser should be large enough to contain the required amount of metal to make up for the shrinkage and to provide this metal it must solidify after the casting i.e. the rate of cooling of the riser should be lower than that of casting.

We change the design at the radius portion; because defect was occur at the head of the casting on the radius portion. In the defective design there was a two small radii at the head portion, where stress concentration was more, so there was a possibility of occurring crack.

Then we had to change the design by making one big radius instead of two small radiuses, so stress concentration at the head portion was decrease and possibility of occurring defect was less.

IV. ANALYTICAL ANALYSIS

Calculation:

D = Largest Diameter of the flange shaft

d = small Diameter of the flange shaft

r1 = small radius at the head portion

r2 = large radius at the head portion

L = total length of the flange shaft

D = 926 mm

d = 406 mm

r1 = 30 mm

r2 = 50 mm

L = 604 mm

❖ Stress concentration factor at radii 1.

$r/d = 30/406 = 0.0738$

$D/d = 506/406 = 1.246$

From the design data book $K_t = 1.72$ (approx).

❖ Stress concentration factor at radii 2.

$r/d = 50/506 = 0.098$

$D/d = 926/506 = 1.83$

From the design data book $K_t = 1.74$ (approx)

❖ After changing the design, there is a one radius of 120 mm. that is shown below.

➤ Stress concentration factor for new design.

$$r/d = 120/406 = 0.2955$$

$$D/d = 926/406 = 2.28$$

From the design data book $K_t = 1.306$ (approx).

- So, the stress concentration factor is decrease and hence chances of failure at radius portion are decrease.
- A stress concentration (often called stress raisers or stress risers) is a location in an object where stress is concentrated. An object is strongest when force is evenly distributed over its area, so a reduction in area, e.g. caused by a crack, results in a localized increase in stress. A material can fail, via a propagating crack, when a concentrated stress exceeds the material's theoretical cohesive strength. The real fracture strength of a material is always lower than the theoretical value because most materials contain small cracks or contaminants (especially foreign particles) that concentrate stress.

V. CONCLUSION

Firstly taken casting part, there were given two radii of casting part. One radii was r_1 30 mm & other radii was r_2 50mm. For r_1 radii stress concentration factor $K_{t1} = 1.72$ & for r_2 radii stress concentration factor $K_{t2} = 1.74$. Now we took only one radius of the casting object instead of two radii of the object which radius $r = 120$ mm which were greater than the r_1 & r_2 . Radii taken $r = 120$ mm & then we got the stress concentration factor is $K_t = 1.306$. The stress concentration factor was decrease and hence chances of failure at radius portion are decrease.

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