WELDLINE STRENGTH ANALYSIS THEORETICAL PREDICTIVE MODEL WITH THE USE OF MOLDLFLOW

Mahesh S. Tetambe[1], Shailesh A. Agrawal[2], Basavaraj Naikmani[3]

[1]DGM at Engineering Tooling Solution at Schneider electric India Pvt Ltd.
[2] Senior Manager at Engineering Tooling Solution at Schneider electric India Pvt Ltd.
[3]Senior Engineer at Engineering Tooling Solution at Schneider electric India Pvt Ltd.

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Abstract - *Molding process can introduce different moulding defects into the final moulded part.*

Here we are looking at most common part defect that can come from injection molding called weld line.

Weld line additionally called as knit line, is a defect that occurs when the injected plastic meets within a mold. When the polymer resin is injected into a mold, it flows through all portions of the mold cavity.

When the two such melt flows collide in a mold cavity, they are supposed to merge back together. The pressure & temperature with which they merge together decide strong or weak weld line.

Based on flow front meeting angle melt line & weld line are identified.

Weld line is usually weaker than melt line & subsequently it reduces strength of moulded part.

The parameters like gate location, part geometry, melt temperature and fill pressure near weld line plays vital role in weld line formation. There is no process to objectify the plastic part strength at weldline area. The structural simulation done on CAD model does not account for the weldline and stresses generated during moulding process in part. Hence a predictive weldline strength model considering in mould stresses is established.

Key Words: Weld line, injection pressure, Simulation

1. INTRODUCTION

Weld line is generally a most common defect, but it is difficult task to eliminate. They usually occur when melt flow fronts collide with each other in a mold cavity. A weak weld line can cause aesthetic issues, or it can significantly weaken the structural integrity of a plastic part.

Part design plays crucial role because non-uniform wall thickness, projections in component like bosses and ribs, as well as holes or depressions can interrupt and split melt flow into separate fronts. Also, multiple gates into a cavity split melt flow into separate fronts. A temperature variation in different sections of mould cavity create a non-uniform flow front.

It is observed that amorphous resins generally provide better weld-line strength than semi-crystalline resins. Adding glass fibres can also contribute to reduction in weld-line strength. The flow pattern of the plastic when it enters the mould cavity through gate is most important to weld-line strength. Minimizing flow interruptions, and care to place them such that the flow fronts are allowed to meet and flow some distance together to merge properly.

Weld lines can be weaker than the surrounding area hence, it is important to understand how weld lines form, and how to optimize their appearance and strength. The flow of molten plastic in a mold does not progress in a turbulent manner as would a fast-moving Newtonian fluid such as water. Also, it does not slide along the walls of the mold cavity. Instead, it moves forward by way of fountain flow. Portions of the long chain polymer molecules become lodged in the stationary and slow-moving layers near the mold surface. This pulls plastic from the center, core region of the advancing flow front. Fresh melt exits the core and rolls out to the mold surface. The flow gets split due to product designs and tool designs aspects leading to weldline formation.

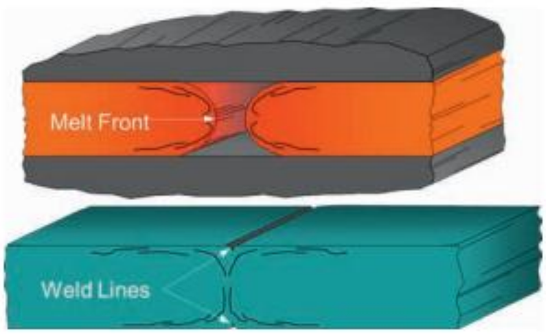

Fig -1: Melt line & weld line

Actual weld line on molded componnet shown below for reference

Fig -2: Weld line

2. WHY SHOULD WE AVOID WELDLINE?

Weldline in injection molding are undesirable, especially when surface appearance and part strength are of high importance. Hence it is important to avoid them for the following reasons:

Weld lines are usually the weakest area on the moulded component. If there is mechanical load coming in thar region then it can easily break or can crack. If the part is designed for a purpose that requires good strength, the reduction of strength caused by weld lines can restrict it from effectively performing such a purpose.

For instance, if you have a weldline around a screw hole in your part, the line might break when one tightens a screw through the hole.

3. HOW TO DO STRENGTH ANALYSIS OF WELDLINE?

Tentative process proposed for parts with mechanical strength requirement at weld line areas –Try to avoid weld line in part where mechanical load is coming. If still weld line cannot be avoided, then the following process to be followed to predict the strength at the weld line area:

1. Get the MF model with stresses mapped for checking breakage at weld line
2. Use the MF model as input to Simcentre or any structural analysis CAE software for strength analysis.
3. Get the force conditions from product designer and failure data of actual component at weld line if its existing part for new part the plastic raw material theoretical data to be used.
4. Perform the structural analysis of part and check the stress generated at the weldline area.
5. Compare the stress w.r.t. allowable stress by the raw material use

4. CASE STUDY:

4.1 Problem statement:

Component breakage during service observed

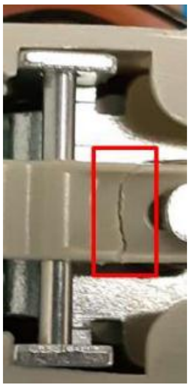

Fig -3: Component Crack

4.2 The weldline strength analysis process followed:

1. The Mould Flow model with stresses mapped. Need to do mould flow simulation for analysis of stresses in the part. With the help of analysis, we can take this part to further analysis in Simcentre

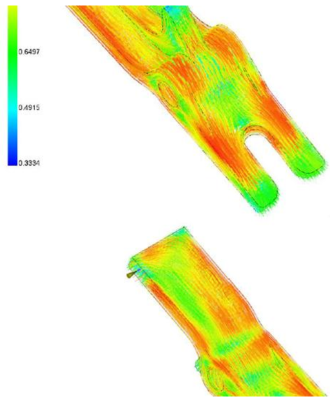

Fig -4: MF model

2. Use the MF model as input to Simcentre for strength analysis.

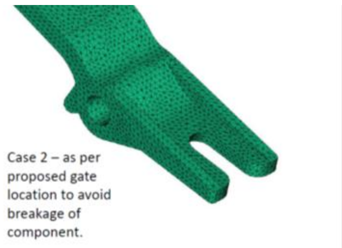

Fig -5: MF stresses Mapped model

3. Get the force conditions from customer and failure data of actual component at weld line.

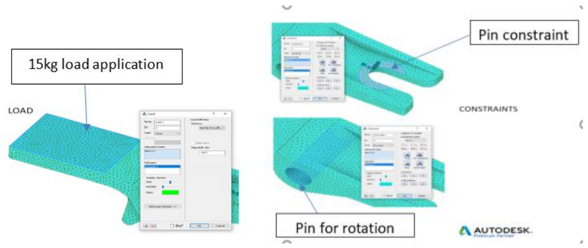

Fig -6: Force conditions

4. Compare the actual data with respect to Simcentre.

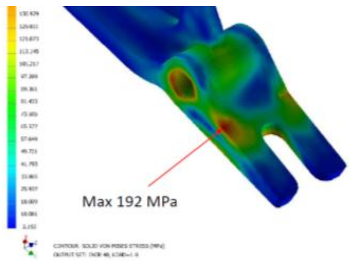

Fig -7: Stress analysis

5. Maximum stress generation is 192 MPa as per mould flow report, while material have stress capacity of 200MPa. The stress generated is at maximum side and without any factor of safety.

6. Due to glass filled material the fiber orientation observed weak at existing gate location hence the gate location was changed in study to get the improved fiber orientation at weld line/breakage area.

7. **Problem cause:** Looking at flow results in existing component, it is seen that breakage area of component has weak weld line, improper fiber orientation and working stress with no factor of safety.

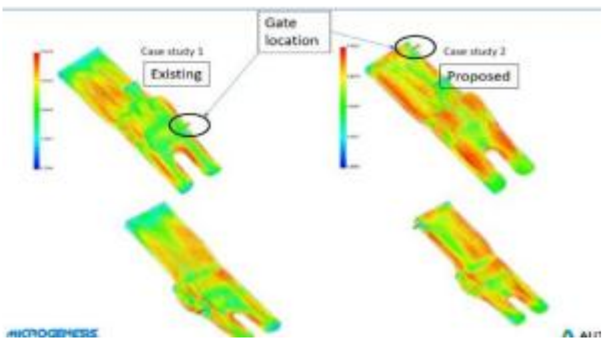

Fig -8: Gate analysis

8. **Results:** Fiber orientation changed from parallel to perpendicular in load condition. Gate location change and improved fiber orientation resulted in increased stress capacity. Additionally strengthening ribs proposed & geometry changes suggested to get improved factor of safety.

5.CONCLUSIONS

With the possible modified gate location & component, it is seen that there is change in flow pattern, further it improved the strength and factor of safety. This objective decision was possible due to use of predictive strength model.

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BIOGRAPHIES

Mr. Mahesh Tetambe
Working as DGM-Tool Design Dept, ETS, PTL Schneider Electric India Pvt Ltd,
Mumbai, Maharashtra.

Mr. Shailesh Agrawal
Working as Sr. Manager- Tool Design Dept, ETS, PTL Schneider Electric India Pvt Ltd Mumbai, Maharashtra.

Mr. Basavaraj Naikmani.
Working as Sr. Engineer- Tool Design Dept, ETS, PTL Schneider Electric India Pvt Ltd, Mumbai, Maharashtra.