FEEDING SYSTEM DESIGN BASICS FOR INVESTMENT CASTINGS

DAVID C. SCHMIDT
Vice President
FINITE SOLUTIONS, INC.

ARTICLE TAKEAWAYS:

- Gate and feeder bar sizes are determined based on thermal modulus data from simulation
- Gates are positioned to provide feed metal to the areas that need it
- • Simulations for design purposes take only a few minutes

THE DESIGN PROCESS

The general design process consists of the following steps:

- Simulation of the 'Naked' Casting
- Gate Sizing and Feeding Design
- Rigging Geometry Creation
- Verification via CFD/Solidification Simulation

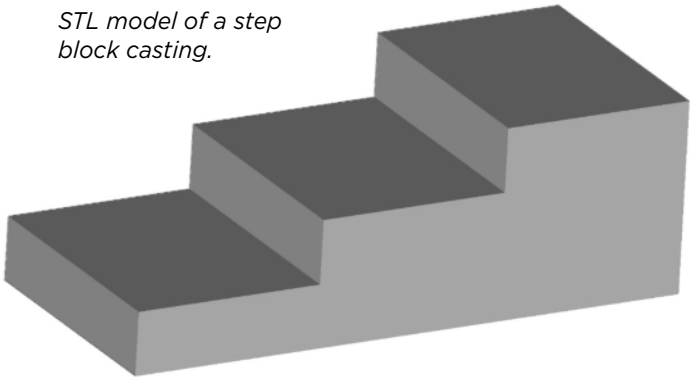
"NAKED" SIMULATION

The first step in the rigging process is to run a simulation of the part 'naked'; without any rigging system. Simulation results show the effects of the part geometry on the overall solidification. In this simulation, filling analysis is typically not done, which provides extremely rapid results, and can point out preferred gate locations which promote directional solidification.

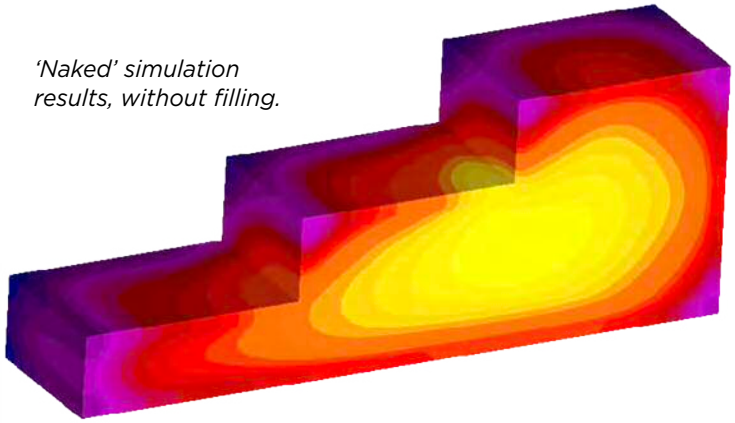
All that is required for the initial simulation is a casting model, normally provided by the customer in STL file format, and basic process details such as casting alloy, shell material, pouring temperature and shell preheat temperature.

GATE AND FEEDER BAR DESIGN

The data from the unrigged simulation can be used to design the rigging components. The gates are typically designed first, followed by the feeder bar. The software uses the progression of solidification, along with a pattern recognition algorithm, to determine the separate feeding paths on the casting. The software can find the last points



STL model of a step block casting.



'Naked' simulation results, without filling.

to freeze on each feeding path, which are the preferred gate contact points.

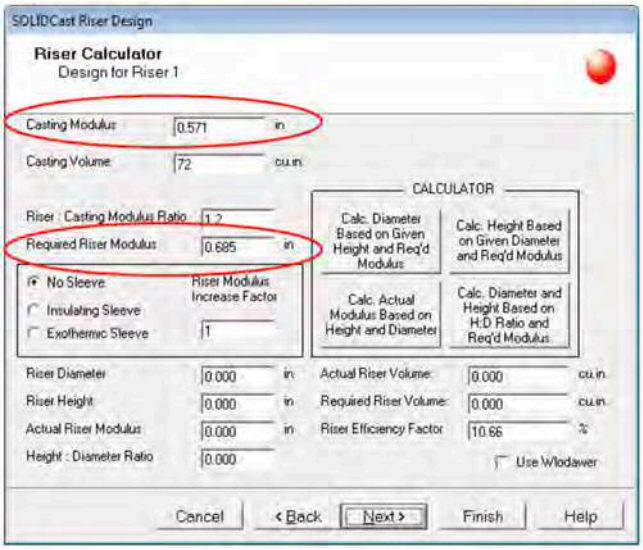
Gate and feeder bar sizes for each feeding zone are calculated using variations on the well-known Modulus Technique. While the Modulus is a geometric calculation (Volume/Surface Area), solidification time information from the simulation is converted into a 'Thermal Modulus.' This takes into account not only casting alloy and shell material, but also the solidification dynamics of the specific situation, including use of insulating materials such as Kaowool or Fiberfrax wrapping.

Here are the guidelines for gate and feeder bar sizing:

Gate and Feeder Bar Sizing

- From the Riser Design Wizard, calculate the maximum modulus of the feeding zone.
- The 2-D modulus of the casting end of the gate will be equal to the maximum modulus.
- The 2-D modulus of the feeder bar end of the gate will be 1.2 times the maximum modulus.
- The 2-D modulus of the feeder bar will ALSO be 1.2 times the maximum modulus.
- For square cross-section, the modulus is the edge length/4.

Once we know the maximum modulus in the casting or the feeding zone, we can calculate the appropriate size for a tapered gate, as well as feeder bar dimensions that will adequately feed that part of the casting. This is done in the Riser Design Wizard, which was originally designed to calculate cylindrical risers for the sand casting process. However, it provides good information for investment castings, too. An example of the wizard screen is shown here:

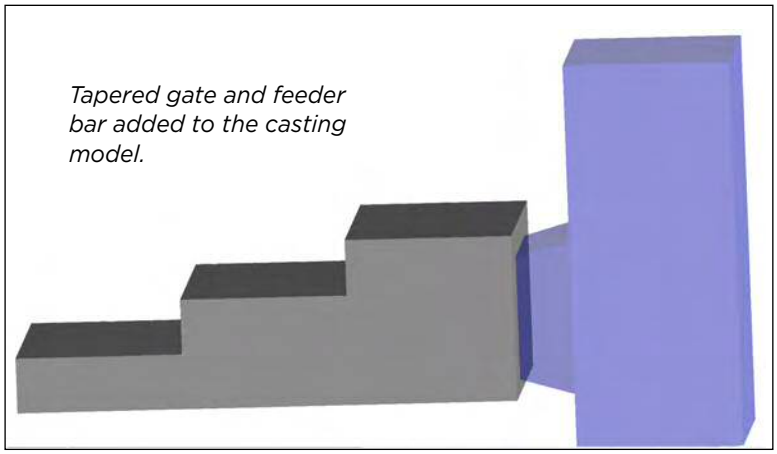


Modulus calculations are used to size both the tapered gate and the feeder bar.

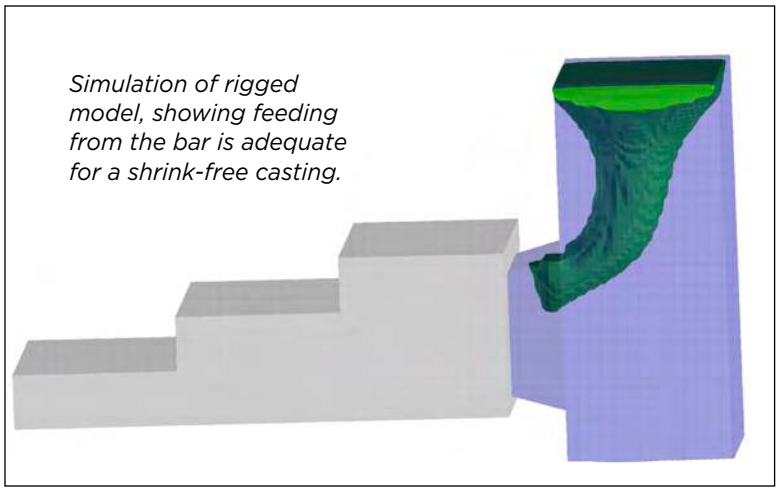
MODELING THE RIGGING SYSTEM

Gate and feeder bar calculations will normally take only a few minutes to perform. Rigging components can be created in CAD or in the simulation software itself. Items that will be used for more than one casting, such as a standard size of pouring cup, can be created in a component format, and re-used as needed, thereby saving considerable time in the model creation phase.

If a library of gating components is developed and used, the entire rigging design process, from loading the unrigged model to having a fully rigged geometry ready for verification simulation, can be as short as 30 minutes or so.

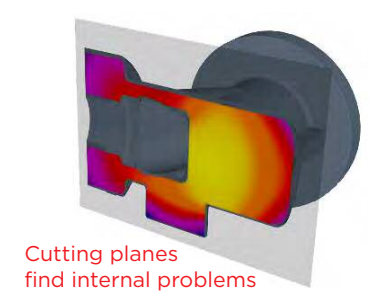


Tapered gate and feeder bar added to the casting model.

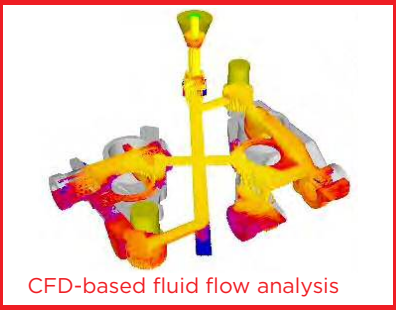


Simulation of rigged model, showing feeding from the bar is adequate for a shrink-free casting.

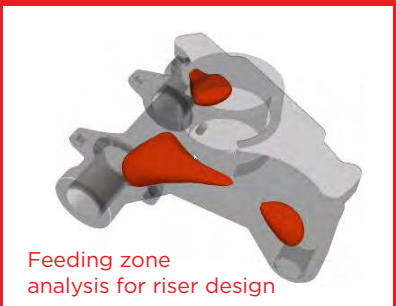
Contact:
DAVID C. SCHMIDT
dave@finitesolutions.com



Cutting planes
find internal problems



CFD-based fluid flow analysis



Feeding zone
analysis for riser design

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