NASCC
THE STEEL CONFERENCE

# Steel Castings in Architecture

AIA A781 | AISC G295
American Institute of Steel Construction

PDH Code:
E 14a Wednesday 73211
E 14b Friday 62326

# Best Practices

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

# Course Description

It is important to recognize the advantages of steel castings and their appropriate applications for a growing market in North America. This program will educate architects on the steel casting production process and material properties, and will present real-world applications of castings in buildings through multiple case studies. The session will also discuss advancements in steel castings, and preview a forthcoming design guide. Architects will gain a better understanding of how and when to design and specify steel castings on their projects.

# Learning Objectives

**Learning Objective 1:**

Compare the advantages and differences between steel castings and cast iron products.

**Learning Objective 2:**

Evaluate how steel castings are produced and delivered to project sites.

**Learning Objective 3:**

Identify steel castings and explore how they are incorporated into commercial projects.

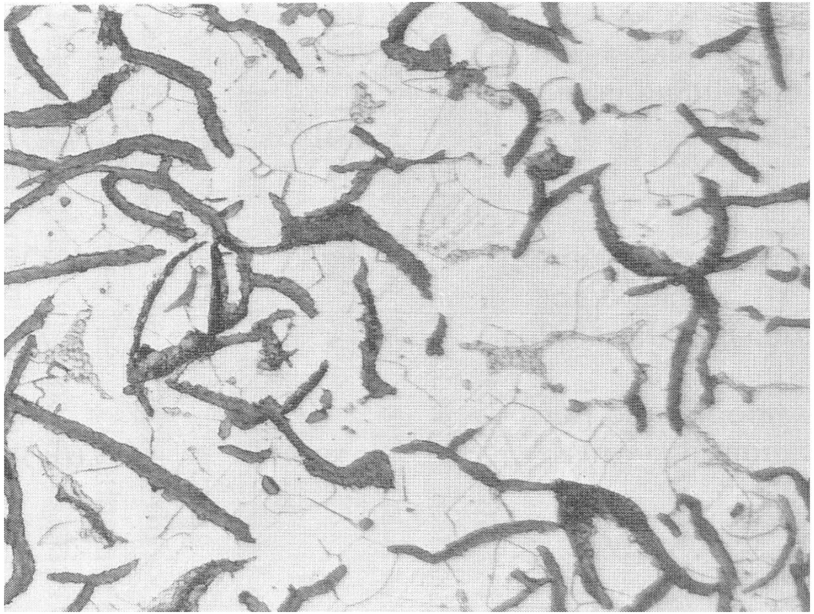
**Learning Objective 4:**

Prepare for designing with steel castings utilizing the forthcoming steel castings research and design guide.

Gray Iron: Graphite flakes surrounding steel: 3.40% Carbon and 2.25% Silicon

Gray fracture surface due to fracture occurring along graphite flakes.

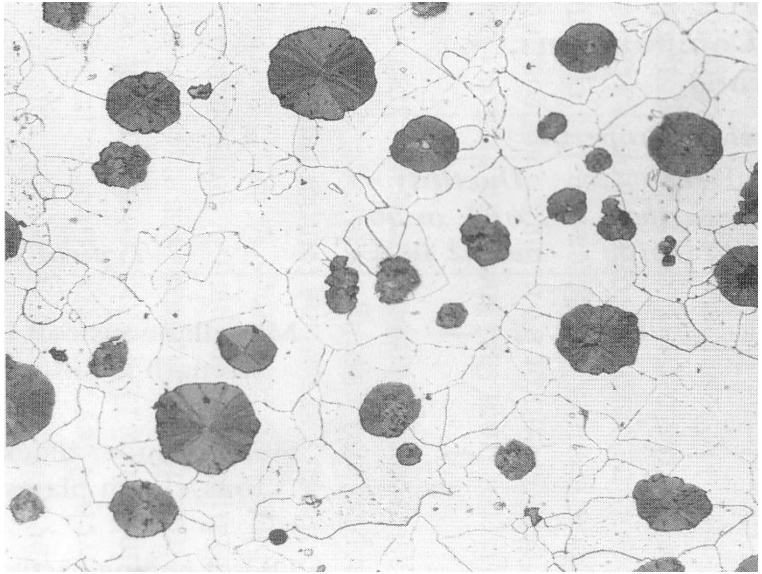
Class 40 GI
YS 200 MPa (29ksi)
Elongation 0.5%
Fracture Toughness 18MPa-m1/2
Compressive Strength 970 MPa (140 ksi)
Not Weldable by ordinary processes



http://www.makeitfrom.com/material-properties/ASTM-Grade-40-ISO-Grade-300-EN-JL-1050-Grey-Cast-Iron

Ductile (Nodular) Iron:  Graphite nodules surrounded by steel:3.5% carbon 2.4% silicon treated with magnesium.

70-50-05 DI
Yield Strength 360 MPa (52 ksi)
Elongation 6.5%
Fracture Toughness 25 Mpa-m1/2
Not weldable by ordinary means



http://www.makeitfrom.com/material-properties/ASTM-70-50-05-ISO-500-7-EN-JS-1050-Ductile-Cast-Iron

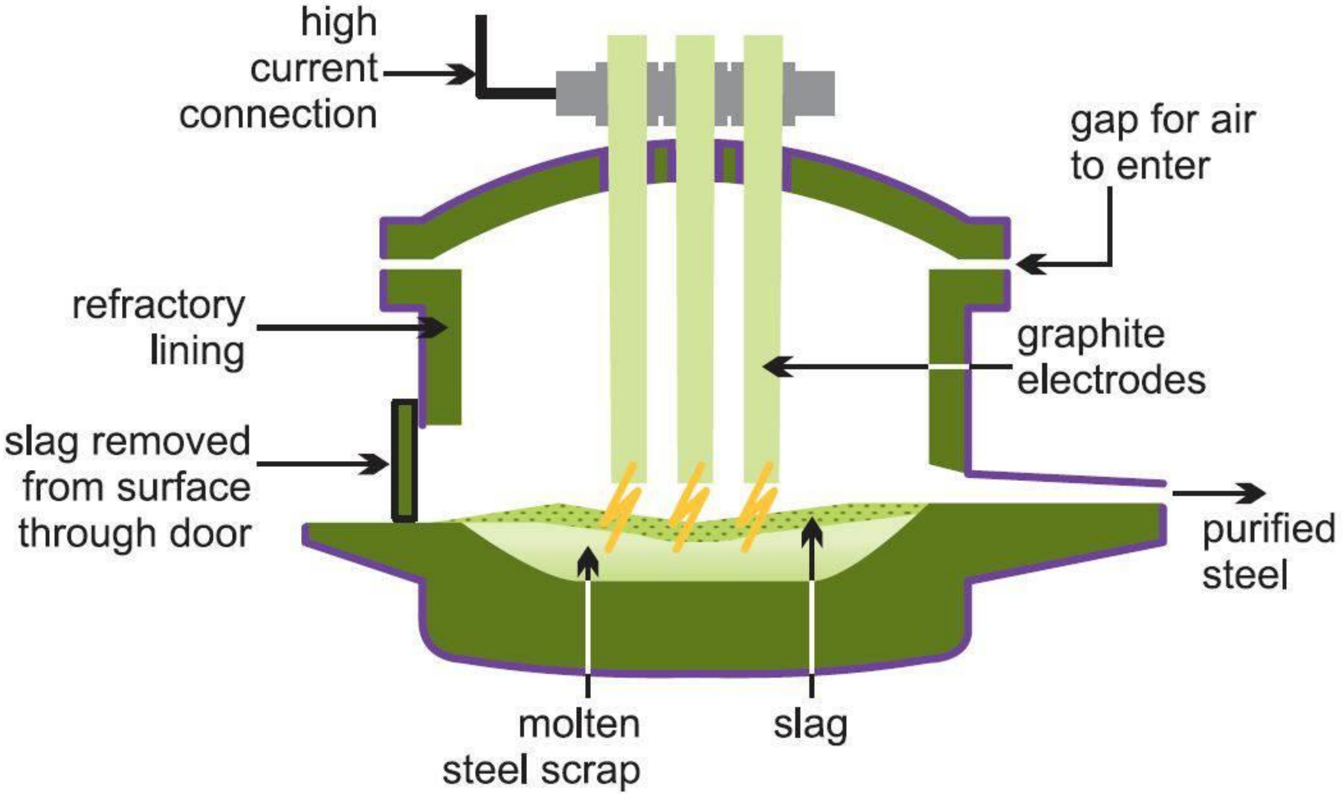
All steel is cast!

Most steel is
made from scrap
melted in an
Electric Arc Furnace.

Steel castings are made from the same scrap pile and with the same type melting and compositions as rolled steels from mills.

Electric Arc Furnaces (EAF) are used for making steel from scrap by steel producers as well as foundries.  They are efficient melters of steel and allow some refining of the steel to meet higher quality requirements.

The EAF works by striking an arc like in welding with three large graphite electrodes on the scrap in the furnace.  This arc melts the steel.



Steel castings are normally heat treated. For most steel castings the heat treatment is to give the steel the properties needed by the purchaser.

In heat treatment of most steels the steel is heated to a high temperature, over 1600F, to dissolve the carbon in the steel. Then the steel is cooled fast or slow depending on the properties needed. After cooling the steel may require a final lower temperature tempering treatment to give the steel the properties required.

Stainless steels are heat treated not to get mechanical properties but to get good corrosion

This shows some of the typical steel samples used for mechanical testing.

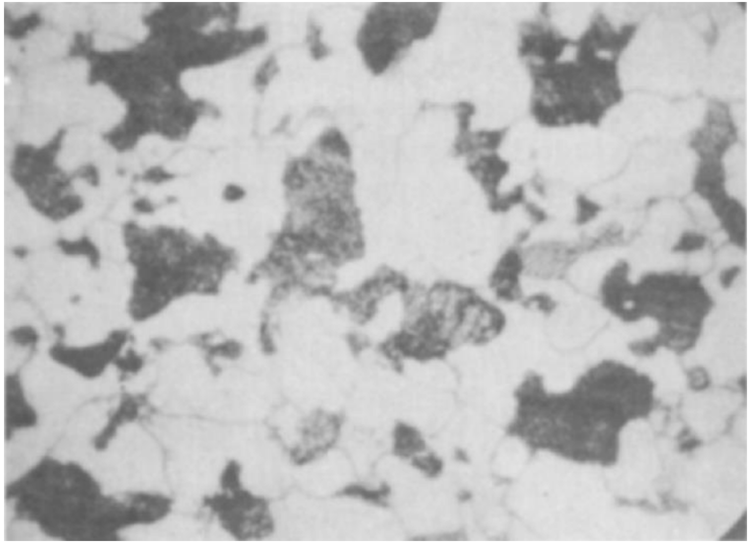
Top left is the tensile specimen that will be pulled and the strength is measured.  The strength before the specimen begins to stretch is the yield strength and the strength to break the specimen is the ultimate strength.  The amount of ductility is measured by how much the specimen stretches before breaking.

Below the tensile specimen is a Charpy V-notch bar.  For some grades, the toughness or resistance to impact is measured, often at low temperatures to see if the steel is brittle.  The sample id hit with a hammer and the amount of energy required to break the specimen is a measure of the toughness.

The sample on the top left is a weld bend bar.  Steel castings are welded in production.  They may also be welded by the purchaser in using the steel casting in their equipment.  For alloys difficult to weld, a welded sample of the steel from the heat is bent in a U shape to show that it can be welded.

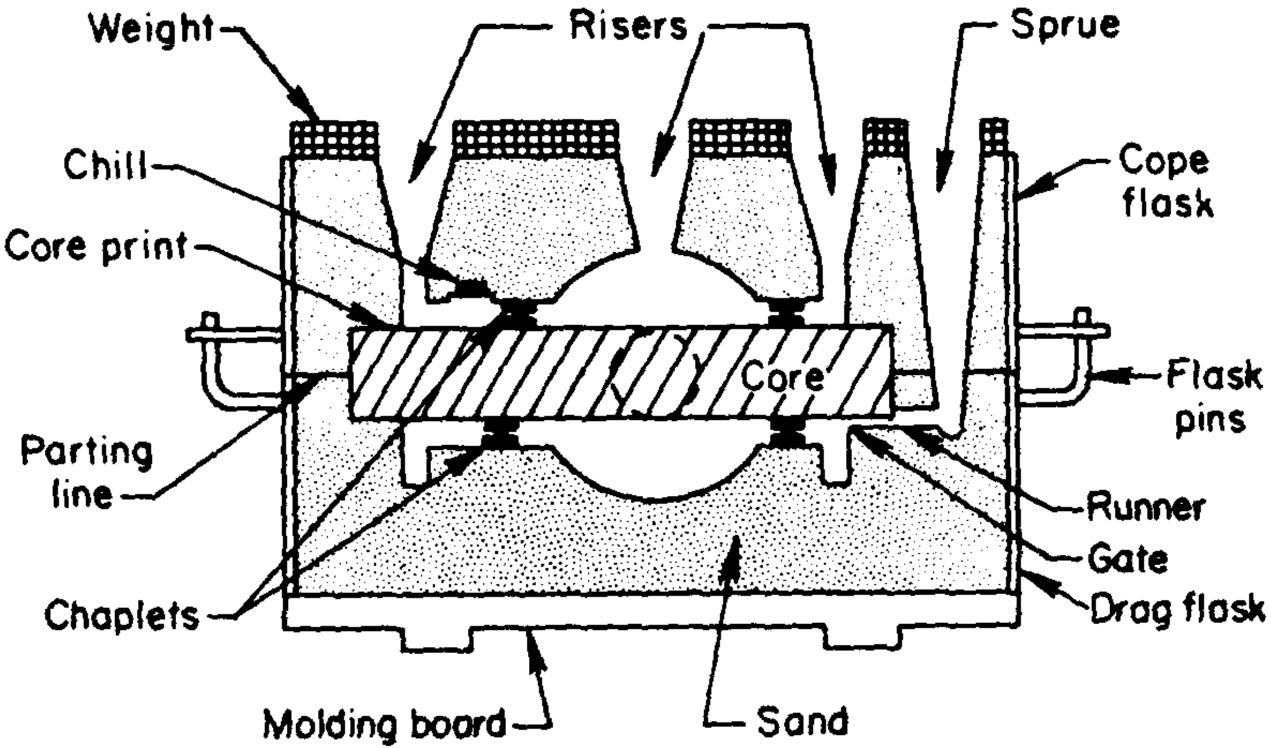
Cast Steel:  Steel alloys equivalent to most rolled or specialty steel grades available as castings.

ASTM A216 WCB (carbon steel)
Yield Strength 290 MPa (42ksi)
Elongation 25%
Fracture Toughness 130 Mpa-m1/2
Weldable with AWS pre-qualified procedures with engineer’s approval

# Typical Sand Mold

Sprue/runner/gate-plumbing system to fill mold
Risers-added to take the shrinkage out of the casting
Chill- steel piece in mold to cause thick section to solidify faster
Weight- added so cope does not float off the drag when the liquid steel is poured into the mold
Cope-top half of mold
Drag- bottom half of mold
Cope/drag flask- steel jacket holding mold
Flask pins- align cope and drag
Parting line- where the cope and drag meet
Core-separate sand part to make internal passages or special features
Core print- cavity in mold to locate and hold core during solidification
Chaplets-small metal spacers to



For steel castings, molds and cores are made with chemically bonded sand, not typically green sand. The sand is coated with an chemical glue or binder in a mixer like the one shown.

Before modern chemical binders were developed, cores were made with oil and baked to create the chemical bond.  Modern binders use chemical reactions to create the bond without baking.  For this reason, chemical binders are also called nobake binders.

This shows the steps for making a green sand mold. The sand rammed into the flask with the pattern. The mold is flipped over and the pattern removed. The core is placed in the mold.

This shows the steps in making the core.



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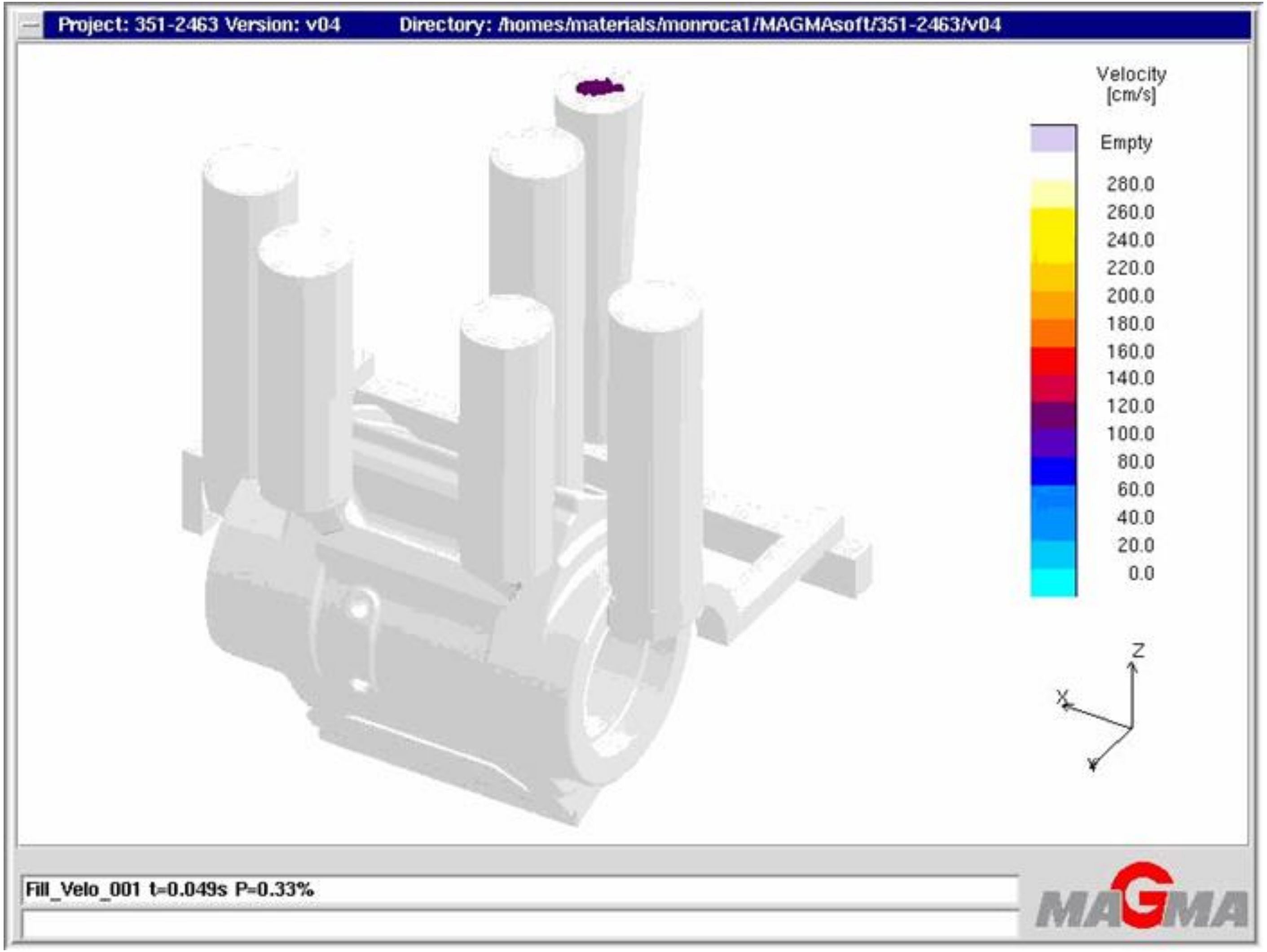
RCT


Postprocessing



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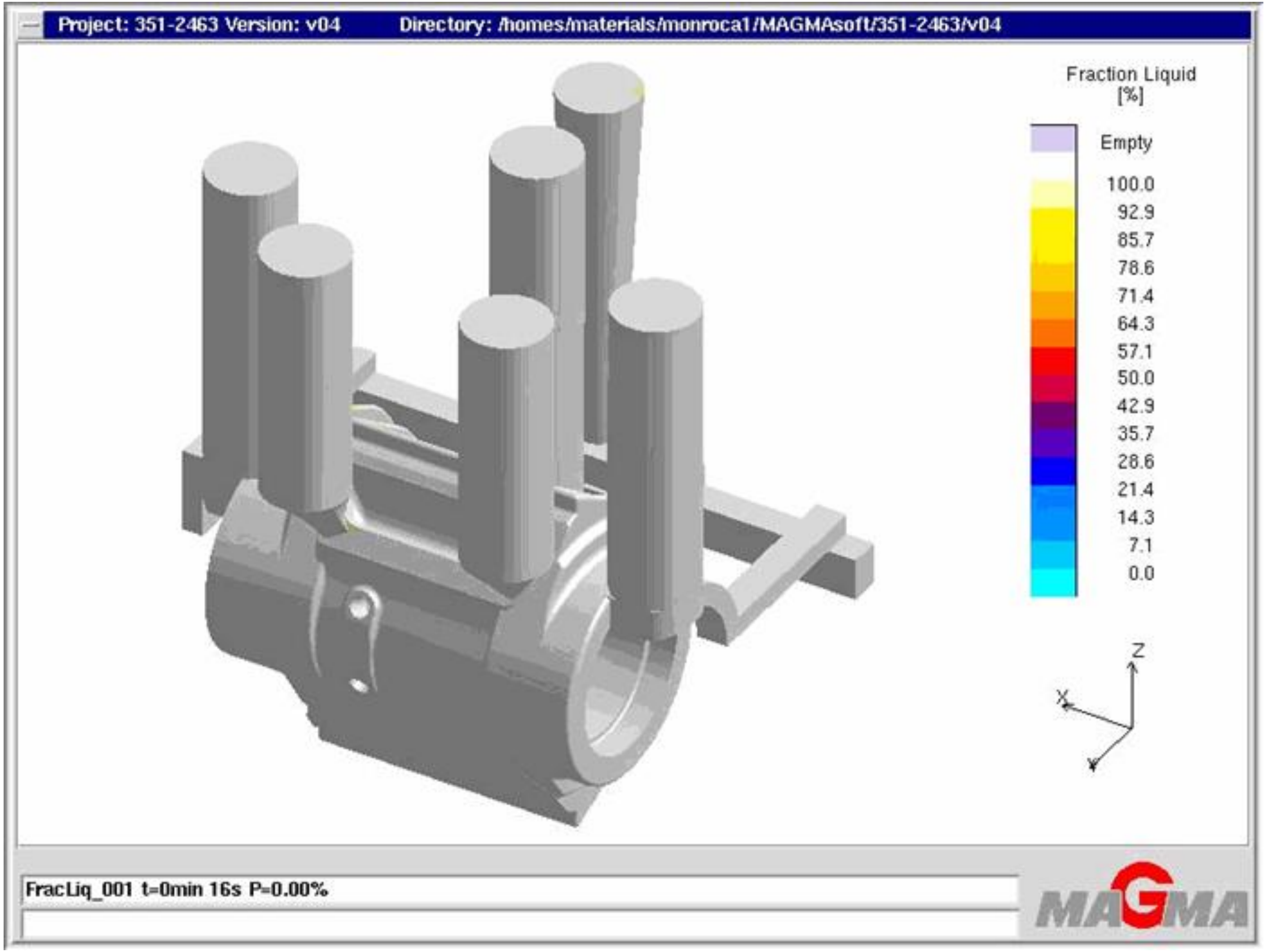
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MAGMA

# Conclusions / Questions

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