# QuikCAST, the key foundry simulation solution for accurate prediction of microshrinkage risks in spheroidal cast iron at Azterlan research center

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Centro Metalúrgico

## THE CHALLENGE

Meeting foundry industrial needs which aim at reducing and improving part quality, QuikCAST was used to predict problems of microshrinkage on a brake calliper, made of sg iron based on GGG-50-7 quality. The objective is to correct and improve metallurgical quality without changing the part geometry.

## THE STORY

*"With spheroidal iron casting, we had to accurately define parameters such as the enthalpy curve of the metal, the inter-dendritic feeding fraction and the critical solid fraction. Using QuikCAST to simulate the casting of a brake calliper, we were able to correct and improve the metallurgical quality of the manufactured parts without changing the mold design."*

Ramon Suarez,
Director of Foundry Department
Azterlan

## THE BENEFITS

- Deliver realistic predictions at each step of the casting process
- Optimize the filling and solidification phases
- Minimize thickness and weight of the part
- Improve metallurgical quality

## THE COMPANY

Based in Durango and Iurreta (Spain), Azterlan is a private, independent and non-profit making organization specialized in metallurgy.

The metallurgical companies operating in the Duranguesado region created the research center in 1975.

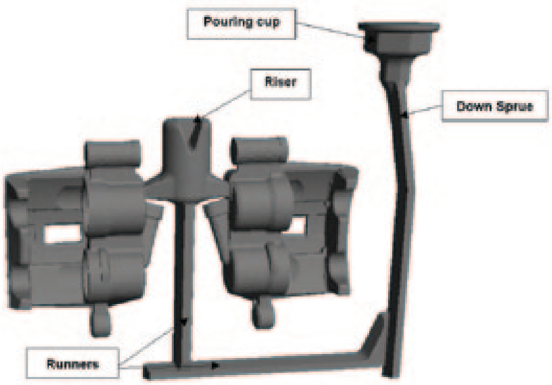
The Azterlan center owes its development to the services and technology transfer provided to over 1500 companies in a wide range of industries. This institute also works in programs to improve machinability and fatigue strength of graphite spheroidal iron.

Brake calliper (GGG-50-7) with 2 cylinders.
Courtesy Azterlan Research Center

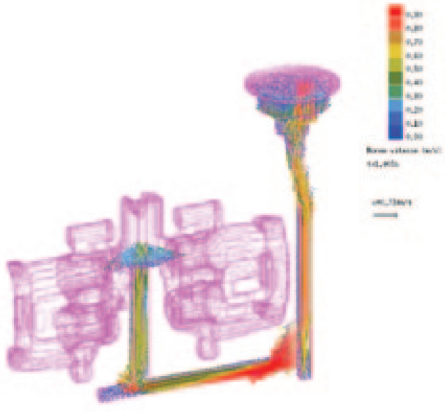
## THE SOLUTION

Choosing QuikCAST, a comprehensive physics-based software package to perform casting of a new brake calliper, the Azterlan research institute achieved the goal to improve the metallurgical quality without modifying the part geometry. The part was manufactured with spheroidal cast iron, of GGG-50-7 quality, using a vertical molding machine that produces 300 molds per hour.

QuikCAST first simulated the filling process into the mold cavity giving high accuracy in the different velocities reached by the liquid metal when entering the parts. Once the filling calculation is finished, QuikCAST simulated the solidification phase. Liquid metal pockets that could remain isolated in more or less solidified areas can be analyzed to detect potential shrinkage or shrinkage porosities.




Filling System used to manufacture the part



Mold cavity filling process with the different velocities reached by the liquid metal when entering the parts

## THE FIRST STUDY

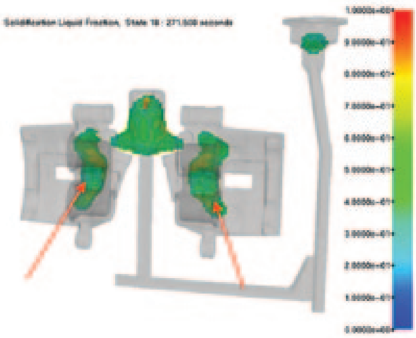
The first study conducted by Azterlan engineers, using QuikCAST, clearly showed an isolated liquid pocket with a high liquid fraction. Such isolated pockets during the last stages of the solidification often lead to micro-shrinkage. This type of defect needs to be avoided, as the part belongs to a critical element of a vehicle, the front braking system. A subsequent X-ray inspection of physical prototypes confirmed the micro-porosity defects predicted with QuikCAST.

The micro porosity problem was analyzed and two causes were identified:

· The part design did not allow for the mass feeding

· Poor metallurgical quality led to the formation of irregular graphite during the eutectic period, therefore the carbon activity was reduced and the expansion of graphite did not compensate for the contraction of liquid in the insulated pocket.

Several improvement techniques were studied to solve the shrinkage problem: increase the self-feeding capacity, modify the solidification pattern of spheroidal iron before inoculation towards graphite and non-carburic morphologies, and better control the sulphur and oxygen activity of the metal treated with FeSiMg.



First study - Isolated liquidmetal pockets

## THE SECOND STUDY

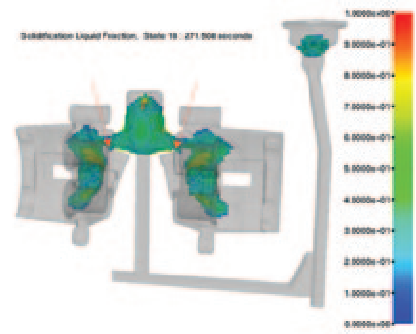
The second study used the same base metal, but the metallurgical quality of metal treated was improved by reducing magnesium activity, therefore increasing magnesium yield and controlling metal deoxidization. Both enthalpy curve and oxygen activity were quite different with the following remarkable differences:

· Outstanding increase of nucleation capacity (this is reflected by the minimum and maximum values of the eutectic temperatures)

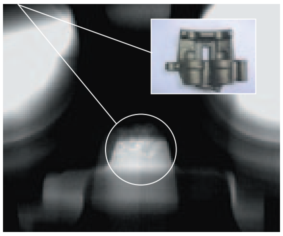
· Important increase of oxygen activity

· Reduction of the quantity of free magnesium dissolved in the metal.

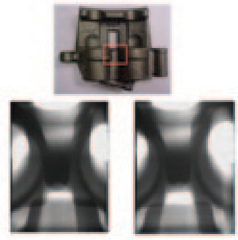
Using these new parameters, the QuikCAST simulation showed little difference during the filling process. However the feeding between the riser and the part was completed within 271 seconds in the first study. In the second study, the mass feeding continued for a longer period, and shows smaller isolated areas which are in a more advanced state of solidification.



Second study - Isolated liquid metal pockets



Areas with micro shrinkage defect



Areas with no sign of micro shrinkage

After being manufactured, the parts were subjected to X-ray control and liquid penetrant inspection.

All parts presented a good level of soundness with no sign of microshrinkage or porosity. An additional test was made: a part was sectioned at a critical location, and analyzed using liquid penetrant inspection. No microshrinkage or porosity was detected, as predicted by the casting simulation.




info@esigroup.com

**ESI Group Headquarters**
**ESI Group**
100-102 Avenue de Suffren
75015 Paris
FRANCE
T. +33 (0)1 53 65 14 14
F. +33 (0)1 53 65 14 12

EUROPE

**CZECH REPUBLIC & EASTERN EUROPEAN COUNTRIES**
MECAS ESI s.r.o.
Brojova 2113/16
326 00 Pilsen
Czech Republic
T. +420 377 432 931
F. +420 377 432 930

**FRANCE**
**ESI France**
Parc d'Affaires Silic
99, rue des Solets - BP 80112
94513 Rungis cedex
France
T. +33 (0)1 49 78 28 00
F. +33 (0)1 46 87 72 02

**GERMANY**
**ESI GmbH**
Sales & Technical Headquarters
Mergenthalerallee 15-21
D-65760 Eschborn
Germany
T. +49 (0)6196 9583 0
F. +49 (0)6196 9583 111

**ITALY**
**ESI Italia srl**
Via San Donato 191
40127 Bologna
Italy
T. +39 0516335577
T. +39 0516335578
F. +39 0516335601

**SPAIN**
**ESI GROUP HISPANIA, S.L.**
Parque Empresarial Arroyo de la Vega
C/ Francisca Delgado, 11 – planta 2ª
28108 Alcobendas (Madrid)
Spain
T. +34 91 484 02 56
F. +34 91 484 02 55

**SWITZERLAND**
**Calcom ESI SA**
Parc Scientifique
EPFL / PSE-A
1015 Lausanne-EPFL
Switzerland
T. +41 21 693 2918
F. +41 21 693 4740

**UNITED KINGDOM**
**ESI-UK Ltd.**
The Magdalen Centre
Oxford Science Park
Oxford OX 4 4GA
United Kingdom
T. +44 (0) 1865 784 829
F. +44 (0) 1865 784 004

SOUTH AMERICA

**SOUTH AMERICA**
**ESI Group South America Ltda.**
Rua Artur de Azevedo, 1857 cj. 45
São Paulo - SP 05404-015
Brazil
T./F. +55 11 3062-3698

NORTH AMERICA

**USA**
**ESI North America**
32605 W 12 Mile Road
Suite 350
Farmington Hills, MI 48334-3379
USA
T. +1 (248) 381-8040
F. +1 (248) 381-8998

**USA**
**ESI North America**
6767 Old Madison Pike
Suite 600
Huntsville, AL 35806
USA
T. +1 (256) 713-4700
F. +1 (256) 713-4799

ASIA

**CHINA**
**ESI-ATE Holdings Limited**
Room 16A,
Base F Fu Hua Mansion
No. 8 Chaoyangmen North Avenue
Beijing 100027
China
T. +86 (10) 6554 4907
F. +86 (10) 6554 4911

**CHINA**
**ZHONG GUO ESI CO., LTD**
Unit 401-404, bldg G,
Guangzhou Soft-Park No. 11, Caipin Road, Guangzhou Science City (GSC)
Guangzhou 510663
China
T. +86 (020) 3206 8272
F. +86 (020) 3206 8107

**INDIA**
**ESI India**
Indrakrupa #17, 100 feet ring road
3rd phase, 6th block,
Banashankari 3rd stage
Bangalore 560 085
India
T. +91 98809 26926
F. +91 80401 74705

**JAPAN**
**Nihon ESI K.K.**
**Headquarters and Sales Division**
5F and 16F Shinjuku Green Tower Bldg, 6-14-1,
Nishi-Shinjuku
Shinjuku-ku, Tokyo 160-0023
Japan
T. +81 3 6381 8490
F. +81 3 6381 8488

**KOREA**
**Hankook ESI**
157-033, 5F MISUNG bldg., 660-6,
Deungchon-3Dong,
Gangseo-ku,
Seoul
South Korea
T. +82 2 3660 4500
F. +82 2 3662 0084

**SOUTH-EAST ASIA**
**ESI Group South-East-Asia Office**
12A-2, Persiaran Puteri 1
Bandar Puteri Puchong
47000 Puchong, Selangor
Malaysia
T. +603-80607993
F. +603-80607661