Compound casting for lightweight components

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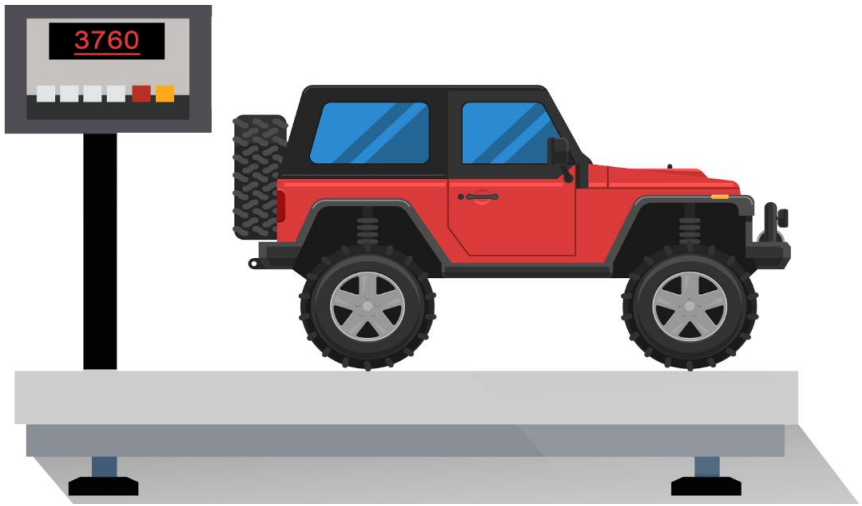
Agenda

- Background
- Compound casting
- Two projects
- Some results
- Upcoming activities
- Acknowledgements

Background

The industrial challenge:

- **Reduce weight:**
  - Improve fuel economy
  - Improve load capacity
  - Reduce emissions
- **One solution:** compound casting



Compound casting: What is that?

- Two metals – one solid and one liquid
- E.g. aluminium cast on solid cast iron

Compound casting

Potential of compound casting

- Gives the possibility to use the right material in the right place
- Might give increased wear resistance, thermal conductivity and/or strength
- Potential for weight reductions of at least 30%
  - 50/50: Al and DCI → ca 33% weight reduction
  - 67/33: Al and DCI → ca 44% weight reduction

Challenges - compound casting

- Which properties are critical for certain application and the joint?
- How can the joint between the two materials be analysed?
- How can the compound casting process be time and cost efficiently implemented in an industrial process?

Research projects

Two research projects:

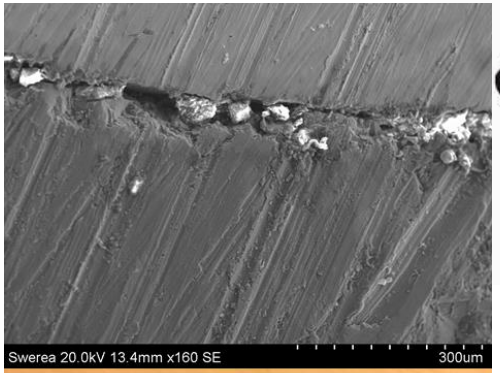
- **TripleC:** A LIGHTer pilot project to study compound casting for weight reduction. Finished in 2017.
- **CompLätt:** An FFI research project in which compound casting is studied with regard to the mechanical and physical properties of the joint. Started in 2018, ends in 2021.

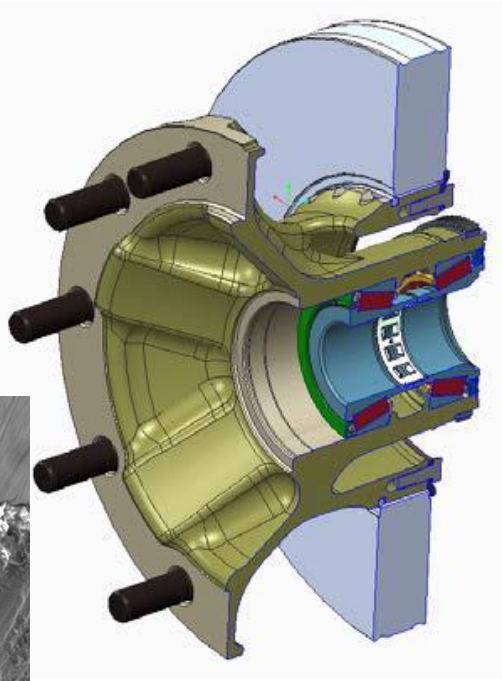
Project focus:

- Achieve metallic bonding between the two metals
- Improve bonding between the two by:
  - Heat treatment e.g. pre-heating and hot dipping
  - Surface treatments
- *Improved bonding through geometrical features or surface topology is also possible*

Results – Pilot project

- Financed by LIGHTer/Vinnova
- 160601-170201
- Fundo Components
- SKF Mekan AB
- Volvo Lastvagnar
- SP Sveriges Tekniska Forskningsinstitut
- Swerea SWECAST





LIGHTer

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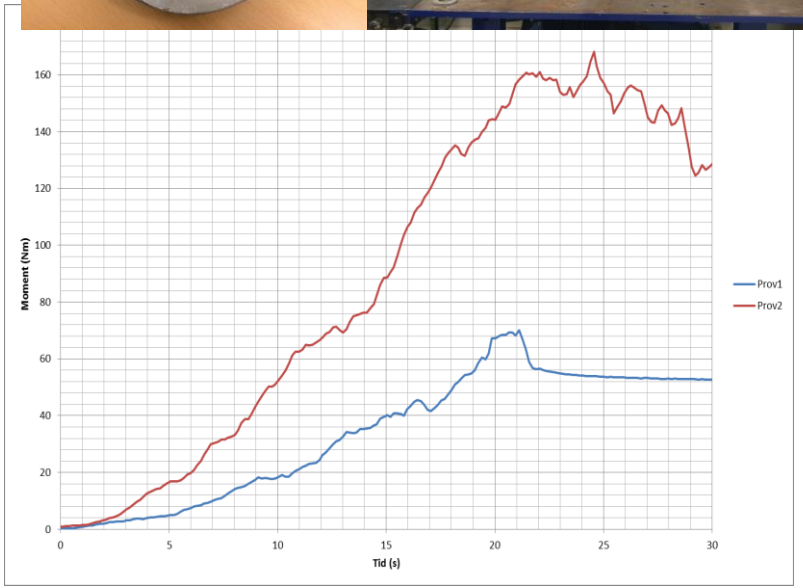
Results – Pilot project

INITIAL TESTS:

- AlSi-alloy compound cast on steel
- Torque testing
- Torque applied through a hydraulic motor
- Low strength - mainly mechanical forces through shrinkage
- Maximum torque around 160 Nm

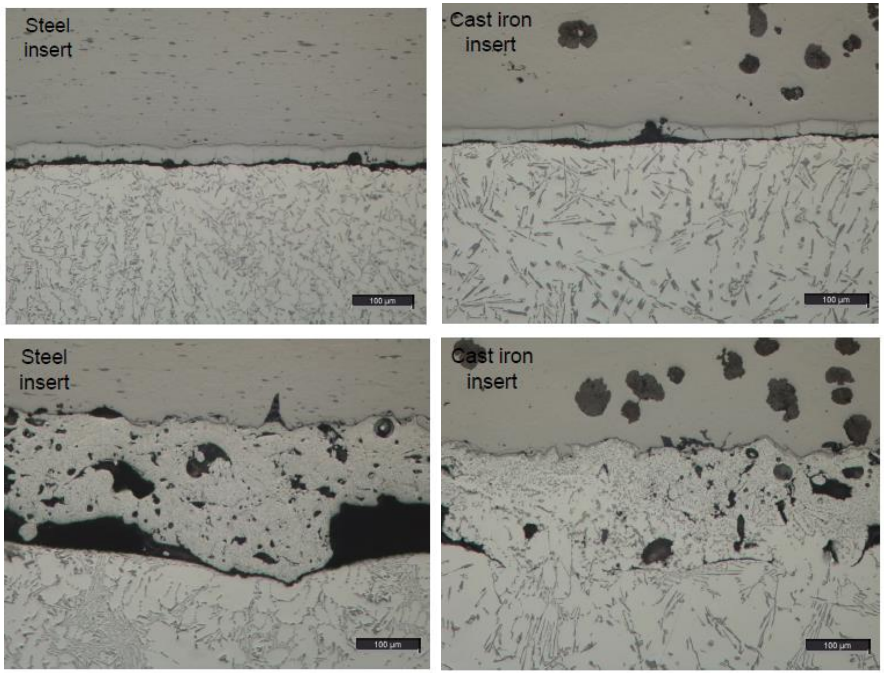


Results – Pilot project

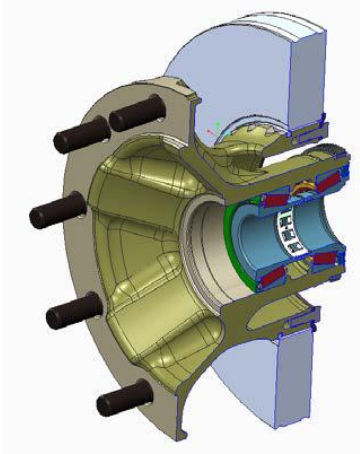
FURTHER TESTING:

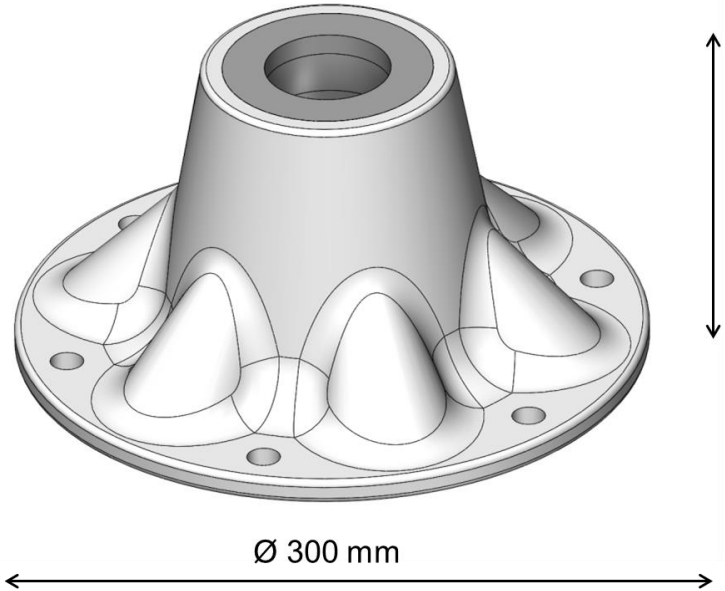
- Surface treated samples were tested
- Zink plating on steel and ductile iron
- Arc sprayed Al12Si on steel and ductile iron

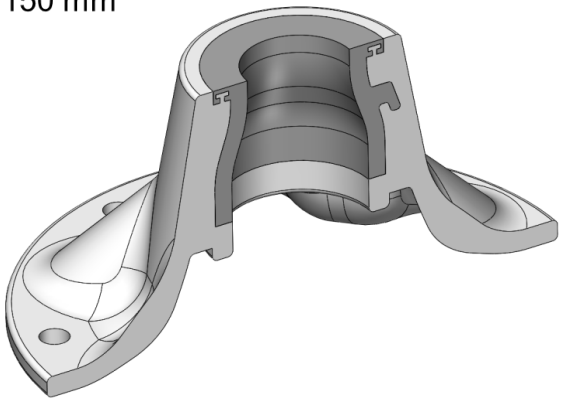
- Imrpoved strength – Maximum strength Al12Si on ductile iron (1080 Nm fractured in the tap of the iron part)

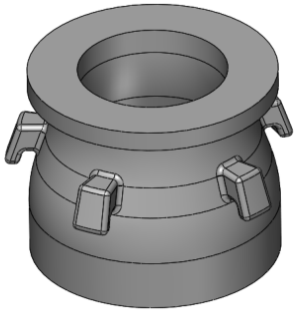


Results – Pilot project









Results – Pilot project

Results – Pilot project

Conclusions – Pilot project

- No surface treatment gave full metallurgical bonding – Other treatments needed
- Thermal conductivity – Quite bad
- Fracture at mechanical testing in the tap – Other test geometry/method needed
- Demonstrator – Casting method works

- Geometry and mass of the included materials influence the diffusion process

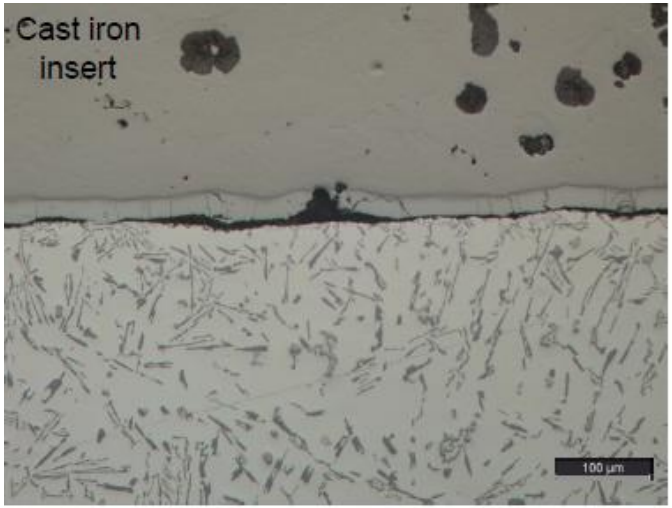
- **These conclusions were brought into the CompLätt project for further research**

Ongoing project – CompLätt

- Financed by FFI
- 180401-210331
- Arvika Gjuteri
- AC Floby
- Fundo Components
- Volvo Lastvagnar
- RISE

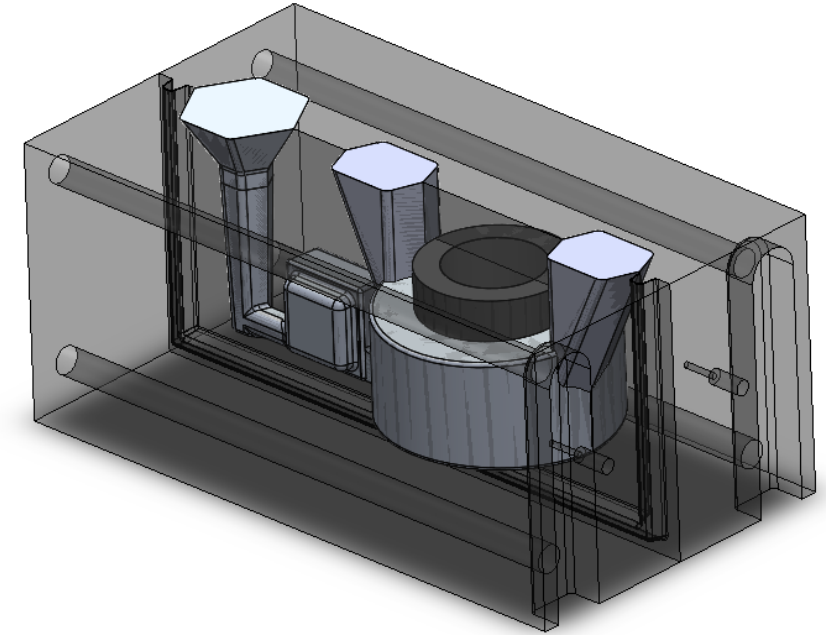
Ongoing project – Surface treatments

Surface treatment
As-is
Etching
Cleaning + Ultrasonic cleaning
Blasting
Thermal spray (AlSi)
Aluminizing
Hot galvanizing
Acid zinc



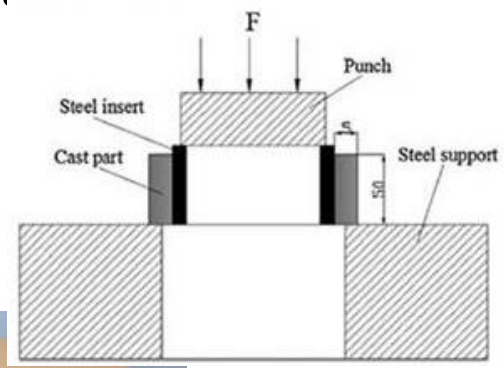
Ongoing project – Specimen geometry

- New geometry of the test specimen to allow for mechanical testing through axial shear and easier analysis of thermal conductivity
- New die for casting of the aluminium on ductile iron tubes
- Electrical heating of the die for pre-heating prior to casting of Al



Ongoing project – Mechanical testing

- New geometry to perform shear testing through axial force application
- Easier to control testing since tests can be performed in standard servo-hydraulic test machines
- Image shows a prototype that have been tested for geometry evaluation

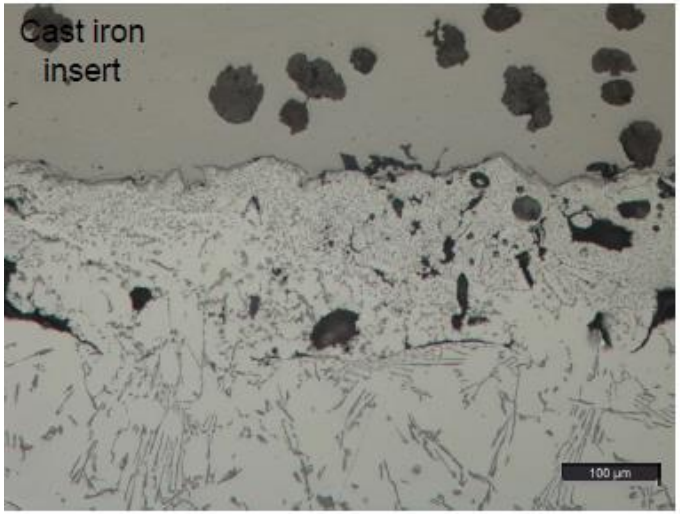


Ongoing project – Thermal properties

- Thermal coductivity over the joint materials are evaluated using hot-disk method
- The thermal conductivity indicates the quality of the achieved joint between the two materials (including the used surface treatment)

Ongoing project – Thesis worker?

- Advertising for thesis workers for the project
- Perform thesis work during spring semester of 2020
- Focus on the thermal influence on diffusion between Al and ductile iron for metallurgical bonding



Conclusions

- This far in the projects compound casting is showing promising results
- Good possibilities for weight reductions
- Need for further work regarding:
  - Best surface treatment
  - How to time and cost efficiently implement compound casting in an industrial process
- *Continued work regarding compound casting will be performed in our on-going project!*

Acknowledgements

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