

# **Current trends in the die casting industry from a tool steel producer's view**

**Ingolf Schruff**

**Kind&Co, Edelstahlwerk, GmbH & Co. KG**

**Wiehl, Germany**

# Survey

**Brief profile of Kind&Co**

**Large die cast structural parts**

**Die cast components with highest surface requirements**

**Results of industrial applications**

**Conclusion**



**Kind&Co: A globally  
operating hot-work  
tool steel specialist**

# **BRIEF PROFILE OF KIND&CO**

# More than 130 years experience in hot-work tool steel solutions



1888

2022

# Expertise in every step of the value chain

Melting  
ESR-Remelting

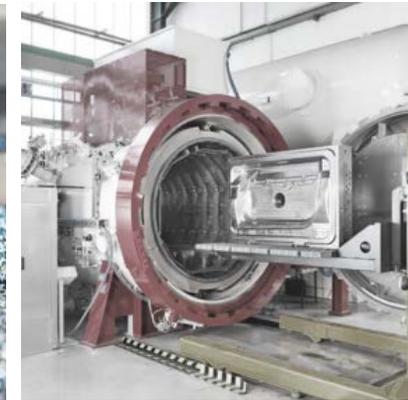
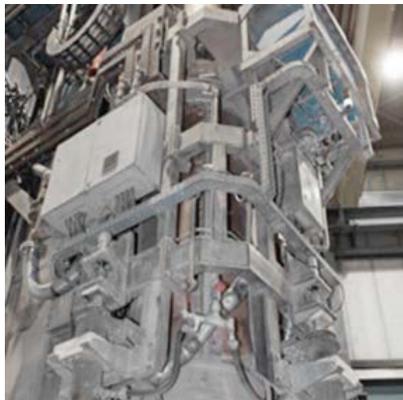
Forging

Hardening  
Annealing

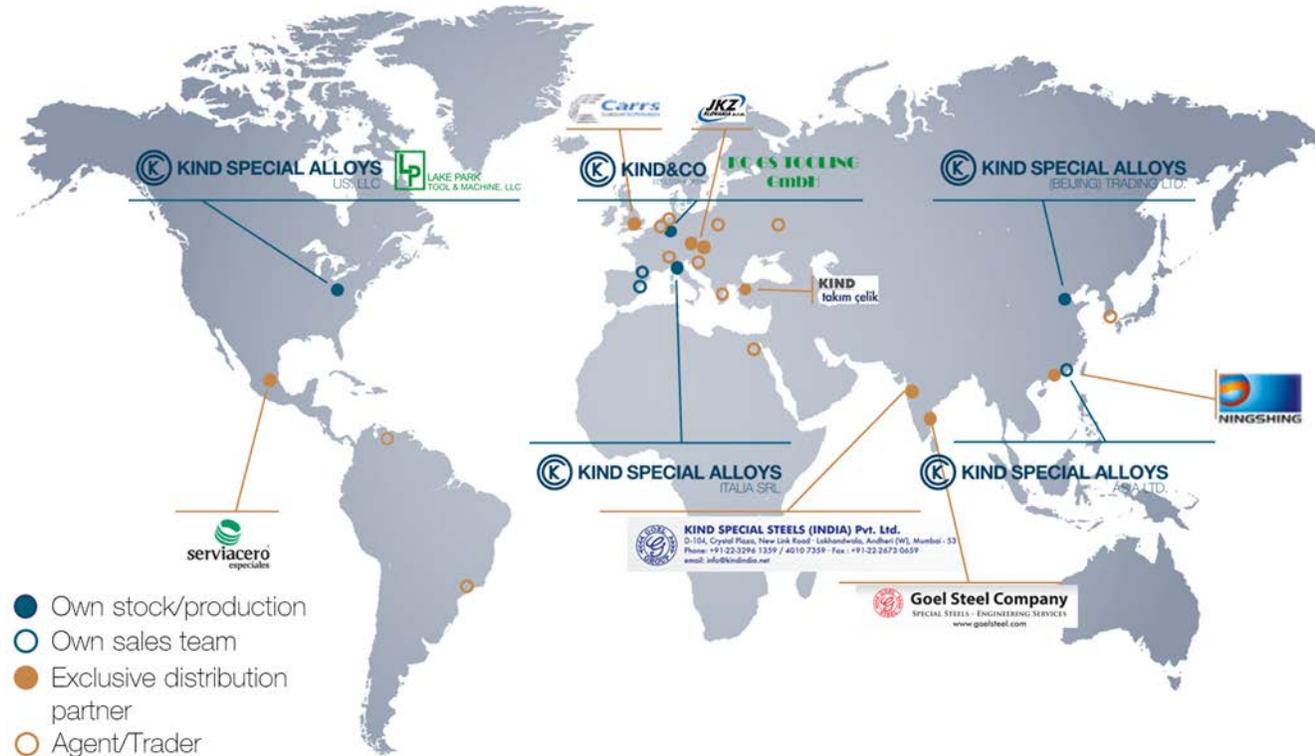
Stocking and  
sawing

Machining

Vacuum  
hardening  
Nitriding



# Global network with uniformly high service standards





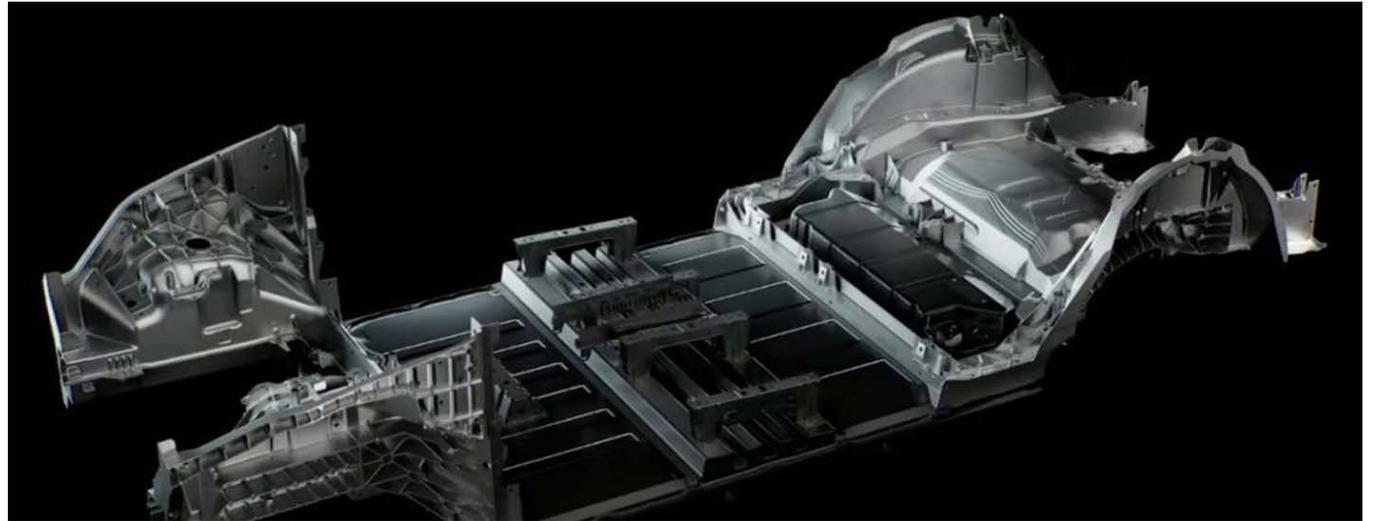
**Rapidly growing market for**

- **Large structural components**
- **Castings with sophisticated surface requirements**

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# **LARGE DIE CAST STRUCTURAL COMPONENTS**

# Specific challenges of large die cast structural components



- Die cast structural components contribute to automotive light weight
- Great technological development from shock towers to cast underbody structures
- Expected growth in electric vehicles supports shift towards large die cast components

Source: Tesla - <https://chargedevs.com/>

# Challenges by aluminum alloys

Aluminum Alloy	Alloy content in mass-%						Casting temp. in F	Purpose
	Si	Fe	Mn	Mg	Ti	others		
226	7,5-9,5	0,80	0,15-0,65	0,05-0,55	0,25	---	1112-1202	Multi
Castasil 21	8,0-9,0	0,50-0,70	0,01	0,03	0,01	---	1256-1328	Structural components
Castasil 37	8,5-10,5	0,15	0,35-0,60	0,06	---	0,1-0,3 Zr	1256-1328	
Silafont 36	9,5-11,5	0,15	0,5-0,8	0,1-0,5	0,04-0,15	0,01-0,2 Sr	1256-1310	
Silafont 37	8,5-10,5	0,15	0,35-0,60	0,06	0,04-0,15	0,006-0,025 Sr	1256-1310	
Magsimal 59	1,8-2,6	0,20	0,5-0,8	5,0-6,0	0,2	0,004 Be	1274-1346	

- Low Fe-concentrations make these alloys chemically aggressive against dies
- High casting temperatures impose high thermal loads on the dies

# Challenges by design



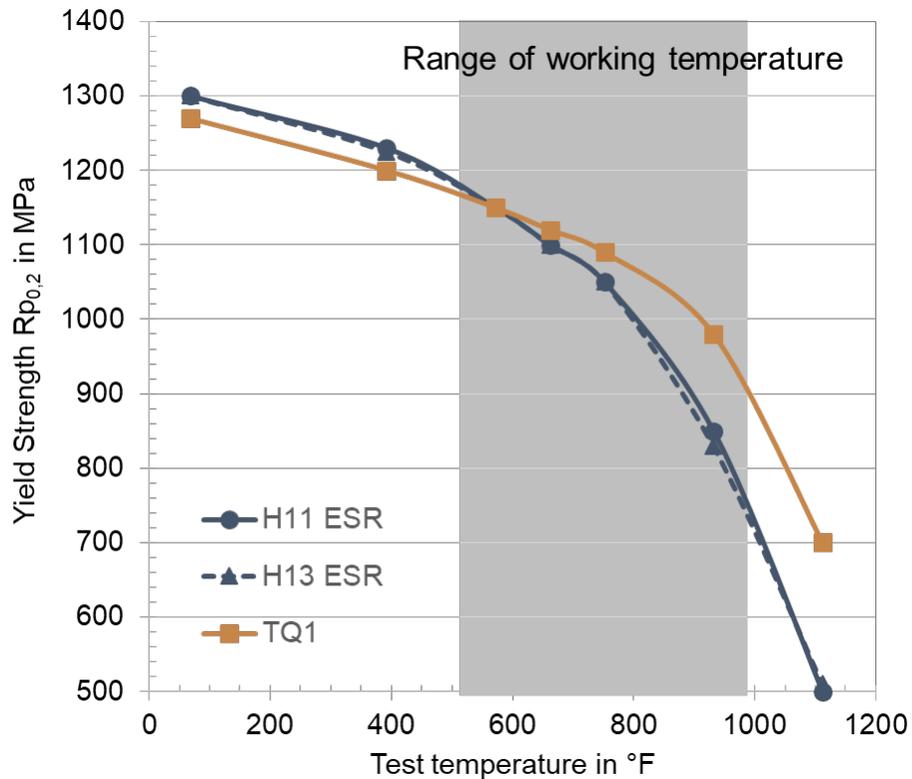
- Dimensional changes, sharp bends, stiffening ribs are spots of stress concentrations during heat treatment and casting
- High casting temperatures and flow rates intensify stresses

# Composition of TQ1 vs. H11 and H13

Steel designation	Alloy content in mass-%					
	C	Si	Mn	Cr	Mo	V
TQ1	0,36	0,25	0,40	5,20	1,90	0,55
H11 ESR	0,37	1,00	0,40	5,20	1,20	0,40
H13 ESR	0,40	1,00	0,40	5,20	1,30	1,00

- Mo for improved hardenability and high-temperature strength
- Lowest levels of undesired trace elements for high toughness
- Utmost care during remelting, forging, and heat treatment provides highest quality

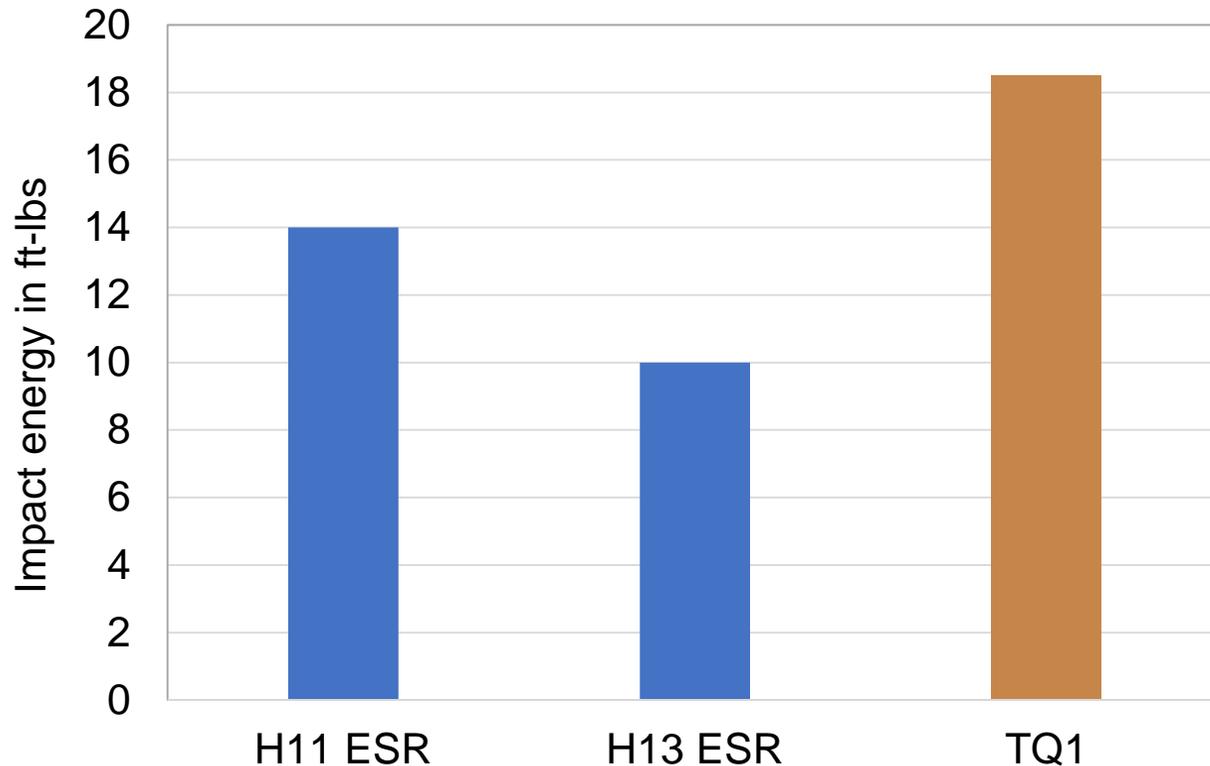
# TQ1 reveals better high-temperature strength



- With each shot the die surface is exposed to high thermal loads
- In the critical temperature range TQ1 develops better high-temperature strength than H13 which leads to better resistance against crack initiation

All samples hardened + tempered to 45 HRC

# TQ1 develops excellent toughness



- Compared to established grades like H11 ESR and H13 ESR TQ1 provides a significantly higher toughness potential

All samples hardened + tempered to 45 HRC

# TQ1 for dies for large structural components

- Compared to H13 TQ1 combines good tempering resistance, improved high-temperature strength and excellent toughness.
- As a result, TQ1 provides excellent thermal shock resistance and cracking resistance. It is therefore suitable for dies with high surface requirements.
- The high toughness level of TQ1 compensates high stresses which come up during the casting process at exposed positions like changes of cross-section of the dies, deep grooves, sharp radii.
- TQ1 has proved its suitability for die casting dies for large automotive components with very high toughness and surface requirements in numerous applications worldwide.
- TQ1 is listed in NADCA #207-2018.

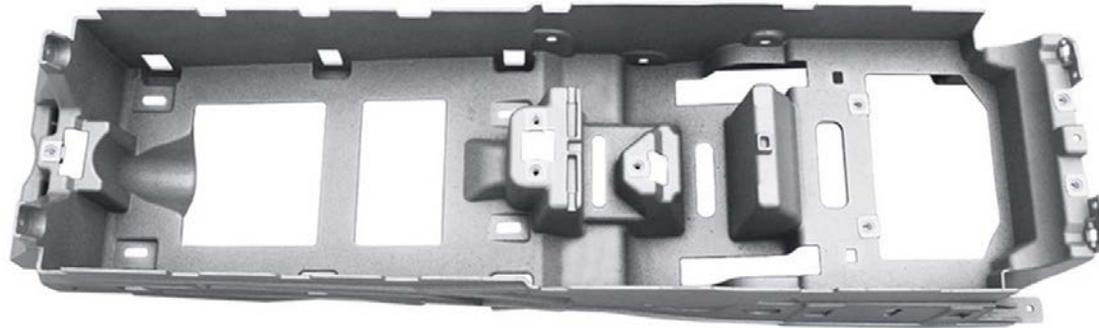


- Surface quality of cast products gains more and more importance.

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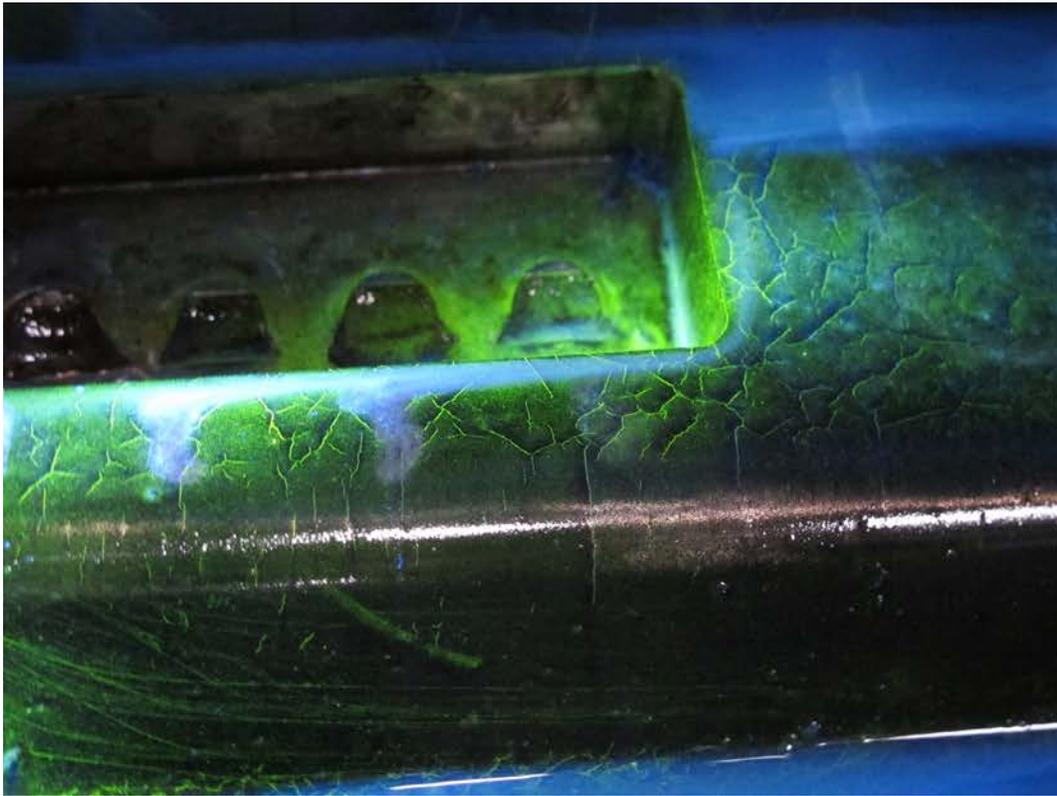
# DIE CAST COMPONENTS WITH ULTRA-HIGH SURFACE REQUIREMENTS

# Die cast components with highest surface requirements



- Ultra-high surface requirements for decorative, aesthetic parts.
- Technical demands for highest surface quality in consumer electronic and telecommunication industry.

# Thermal shock cracks reduce the quality of the cast products

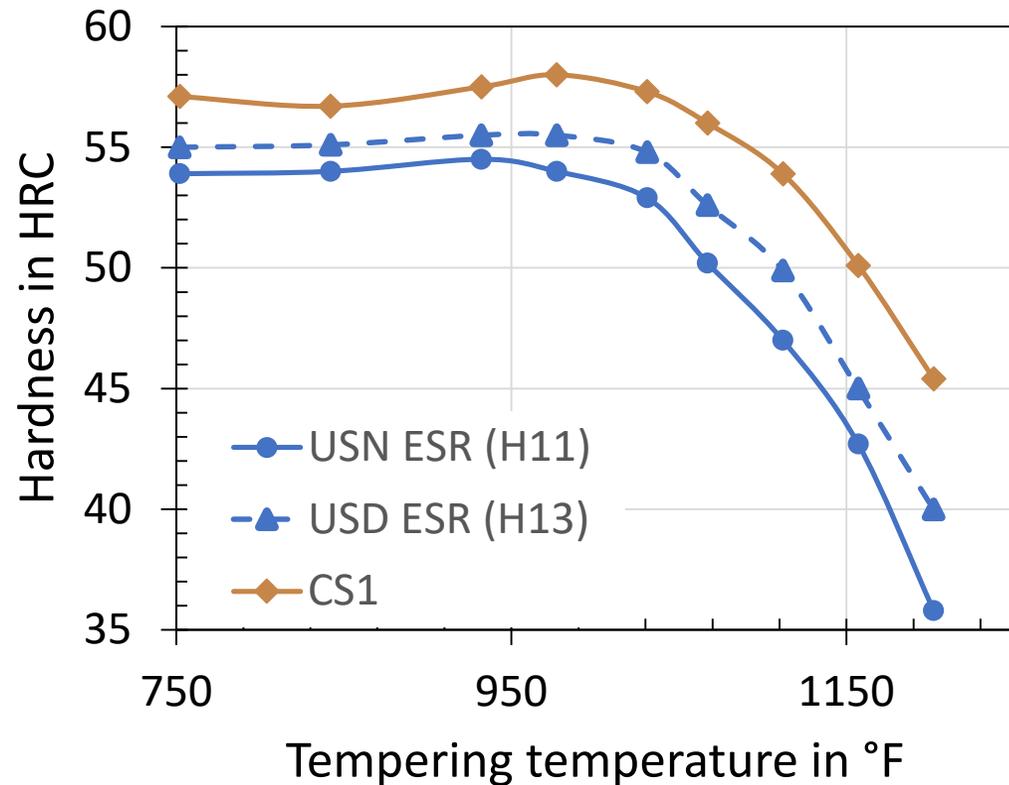


# Alloy concept of CS1 optimized for toughness at elevated hardness

Steel designation			Alloy content in mass-%						
Brand	AISI	Mat.-no.	C	Si	Mn	Cr	Mo	V	Nb
USN ESR	H11	1.2343	0,37	1,00	0,40	5,20	1,20	0,40	-
USD ESR	H13	1.2344	0,40	1,00	0,40	5,20	1,30	1,00	-
CS1	-	-	0,50	0,30	0,40	5,00	1,90	0,55	+

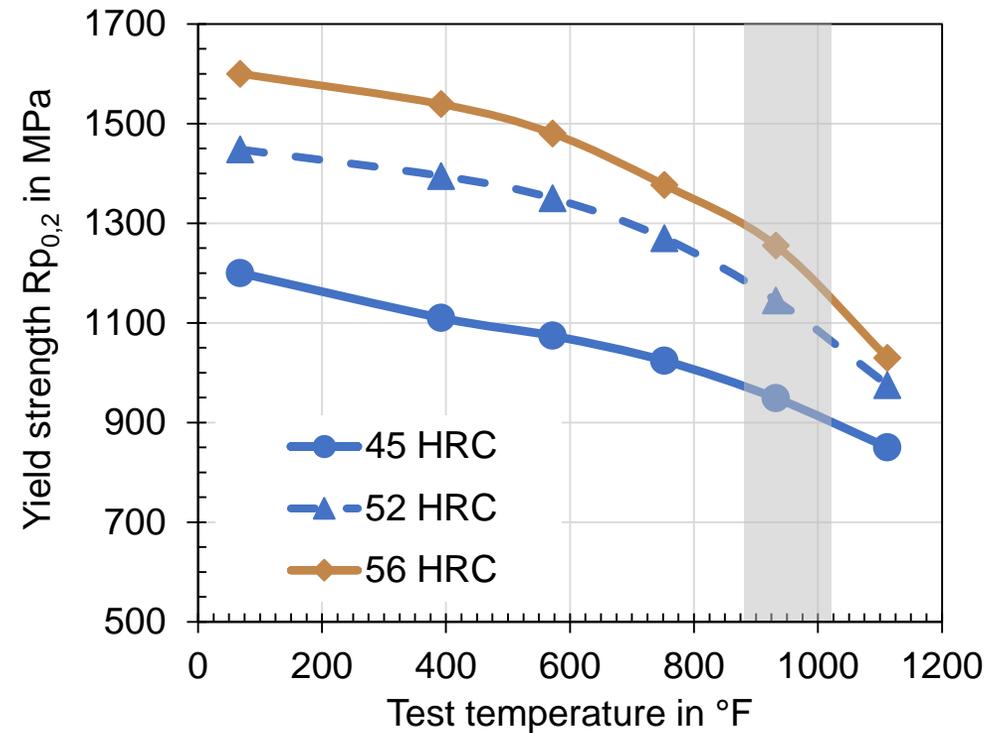
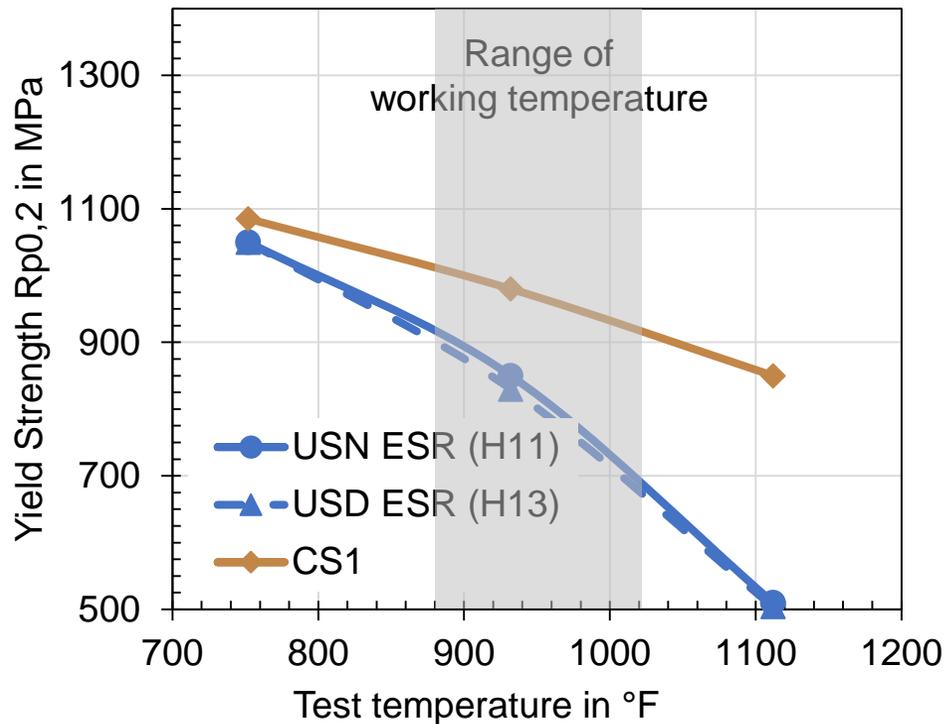
- Higher carbon for hardness and wear resistance (carbides)
- Mo for improved hardenability and high-temperature strength
- Nb dose to support grain refinement thus toughness
- Lowest levels of undesired trace elements

# CS1 provides elevated hardness and improved tempering behavior



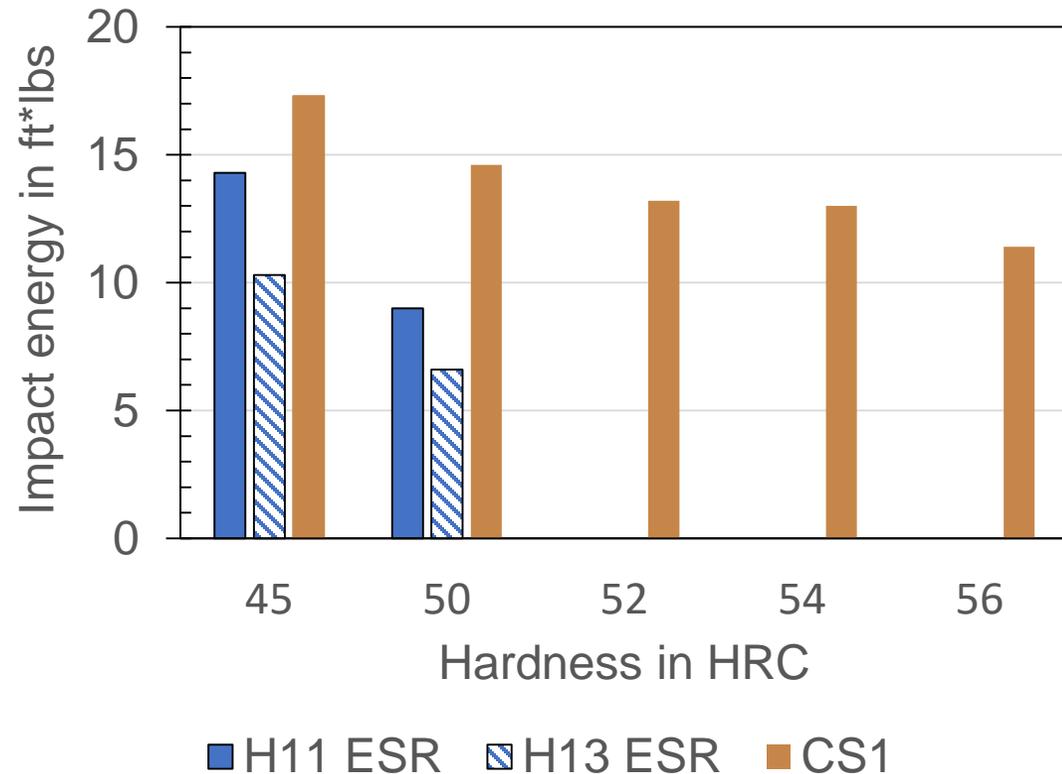
- Higher secondary hardness maximum compared to H11 and H13.
- Improved tempering resistance compared to H11 and H13.

# CS1 exceeds H11 and H13 in high-temperature strength



- Increasing hardness leads to an even higher high-temperature strength

# Despite higher hardness CS1 offers improved toughness



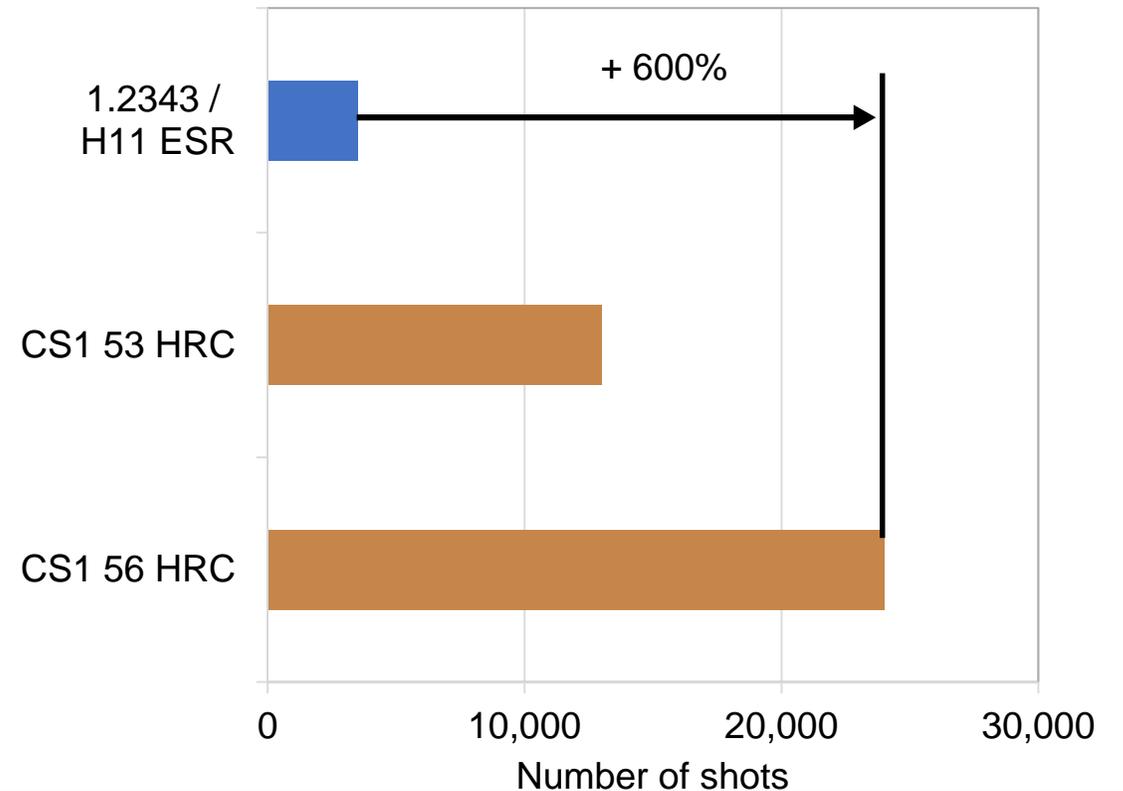
- CS1 offers an improvement of impact toughness by more than 20 % compared to H11 and H13.
- ISO-V-notch samples taken from the center of forged bars (short transverse).
- H11, H13 (45 HRC) acc. to NADCA #207-2018



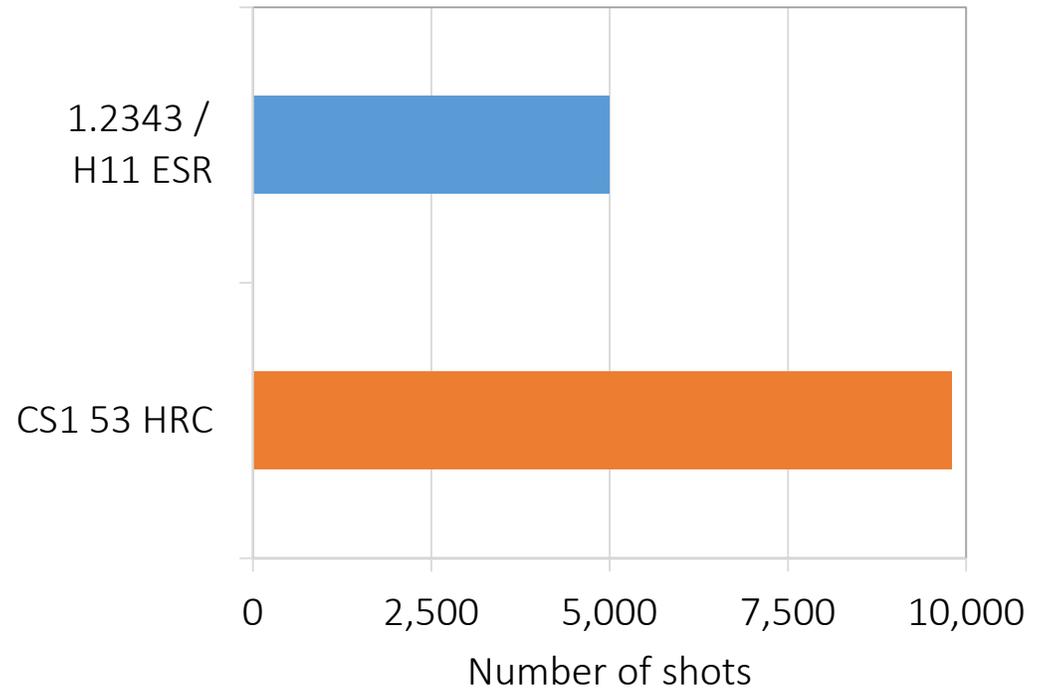
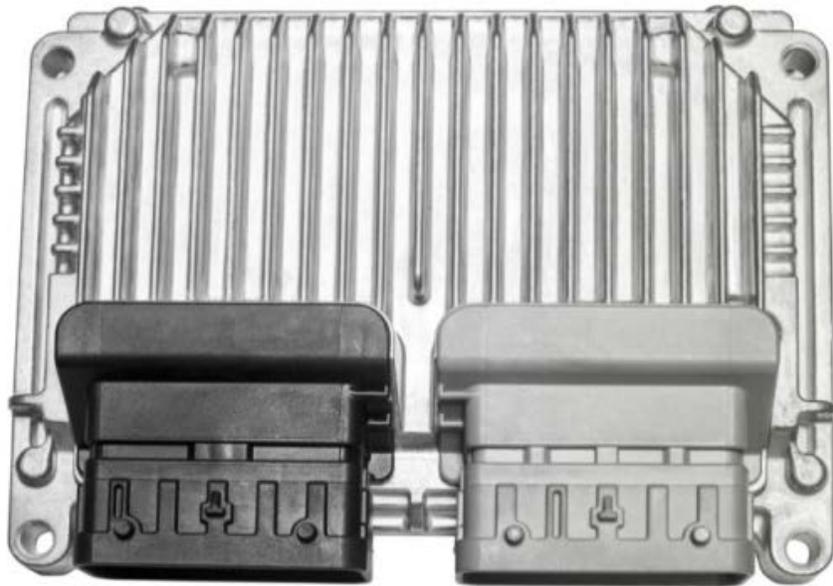
**CS1 leads to significant improvement of die performance**

# **CASE STUDIES WITH DIES OF CS1**

# Case 1: Motorcycle break lever holder and performance data of the dies



# Case 2: Cover for automotive storage unit and performance data of the dies



- CS1 extends lifetime of dies for cooling fins significantly.

# Results of further application trials with dies of CS1 (1/2)

Application	Request	Dimension in in.	Hardness CS1 in HRC	Compared steel	Hardness in HRC	Result
Al housing (electronics)	Very high surface quality, no traces of cracks	13.8 x 15.7 x 4.8	49 ± 1	H11 ESR mod.	47 ± 1	Wear reduced by 30 % after 90.000 shots
Center console German sports car	Very high surface quality, visible part	4.9 x 4.1 x 31.9	49 ± 1	H11 ESR	n.a.	130.000 shots, more than expected
Carrier for rear spoiler German sports car	Very high surface quality, painted component	5,5 x 19.3 x 4.3	49 ± 1	H11 ESR	n.a.	Customer satisfied after 60.000 shots, starts further applications

# Results of further application trials with dies of CS1 (2/2)

Application	Request	Dimension in in.	Hardness CS1 in HRC	Compared steel	Hardness in HRC	Result
Engine block for a German motorcycle	Very high surface quality, visible part	13.6 x 13.6 x 4.3	48 – 50	H11 ESR	n.a.	Trial successfully launched. Earlier dies to be scrapped after 20.000 shots
Gas pedal for tractor	High surface requirements	15.2 x 14.0 x 4.3	52 – 54	H13 ESR mod.	n.a.	After 30.000 shots clear advantages for CS1
Engine cover for tractor	Tight manufacturing tolerances	13.8 x 14.2 x 4.1	51 – 53	H13 ESR mod.	48 ± 1	Very good results. CS1 replaced H13 ESR mod.



**The selection of  
appropriate premium  
hot-work tool steels  
improves die performance**

# **CONCLUSION**

# Conclusion

- The die casting industry faces two technological challenges:
  - Large die cast structural components
  - Die cast components with highest surface requirements.
- Large structural components:
  - High casting temperatures, flow rates and special aluminum alloys require die steels with improved properties.
  - TQ1 has proved its suitability for dies for large components worldwide successfully.
- Super-high surface requirements
  - CS1 has been developed to combine higher working hardness with excellent impact toughness
  - Result: Outstanding thermal shock resistance.
  - Actual case examples prove significantly longer die life, improved product quality, less reworking and maintenance costs.
  - CS1 passed all tests for the next edition of NADCA #207 successfully.

# Thank you very much for your attention!

Presenter:

Ingolf Schruff  
Kind & Co., Edelstahlwerk, GmbH & Co. KG  
Bielsteiner Str. 124 – 130  
51674 Wiehl, Germany  
[www.kind-co.de](http://www.kind-co.de)  
[Ingolf.Schruff@Kind-co.de](mailto:Ingolf.Schruff@Kind-co.de)

Your contact in USA:

Kind Special Alloys US, LLC  
1221 Velma Court  
Youngstown, OH 44512  
[www.kind-co.com](http://www.kind-co.com)  
Raymond Fryan: [Raymond.Fryan@Kind-special-alloys.com](mailto:Raymond.Fryan@Kind-special-alloys.com)  
Travis McQuiston: [Travis.McQuiston@Kind-special-alloys.com](mailto:Travis.McQuiston@Kind-special-alloys.com)