

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

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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



Expertise in every step of the value chain

**Melting
ESR-Remelting**

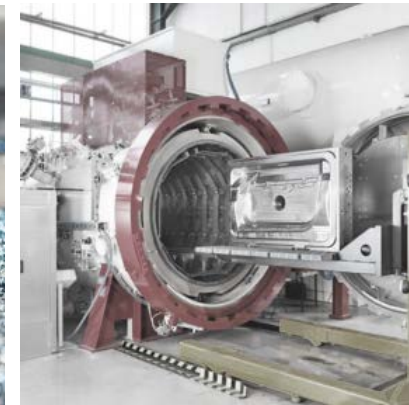
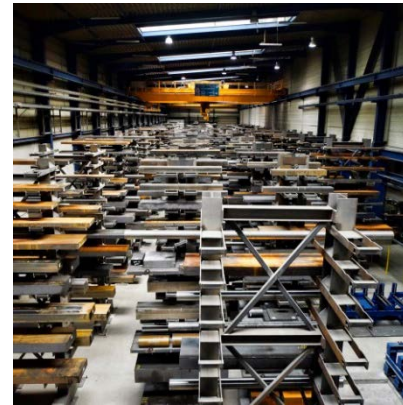
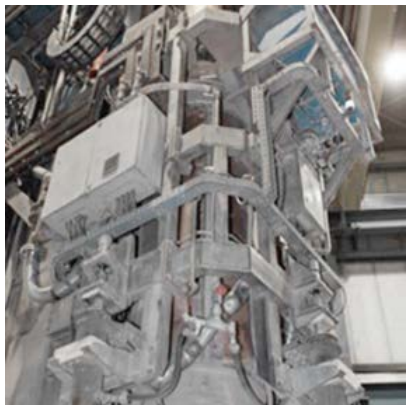
Forging

**Hardening
Annealing**

**Stocking and
sawing**

Machining

**Vacuum
hardening
Nitriding**



Global network with uniformly high service standards



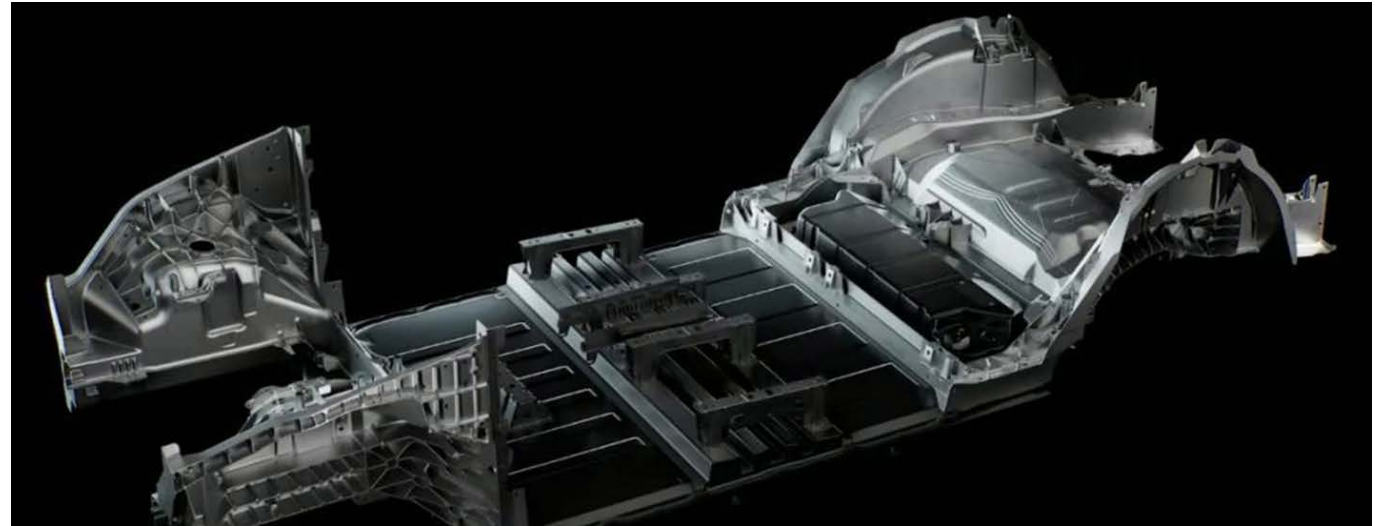
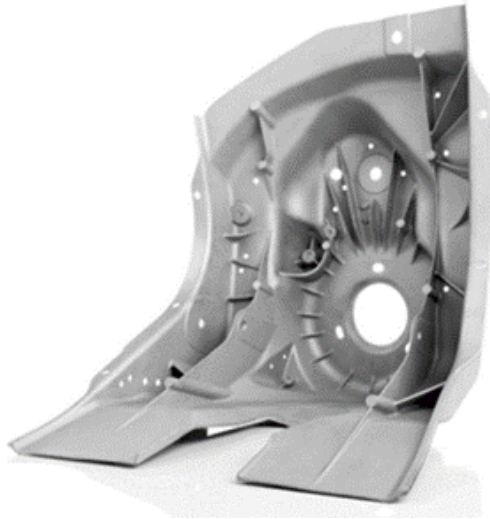


Rapidly growing market for

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

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 compo- nents
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



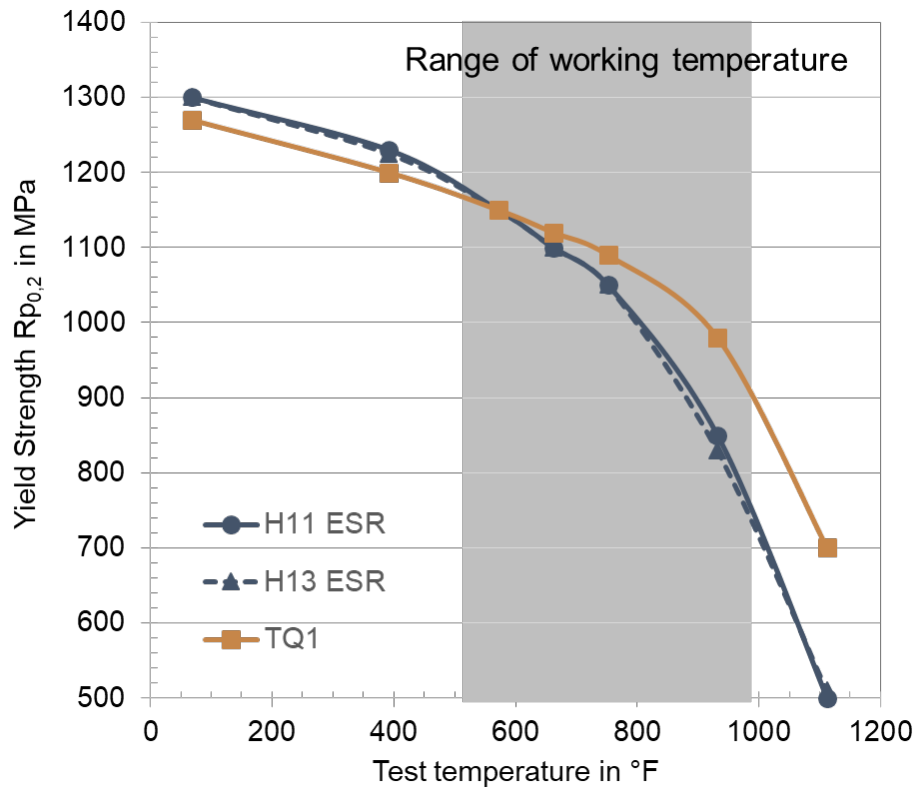
- Dimensional changes, sharp bends, stiffening ribs are spots of stress concentrations during heat treatment and casting
- High casting temperatures and flow rates intensify stresses

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

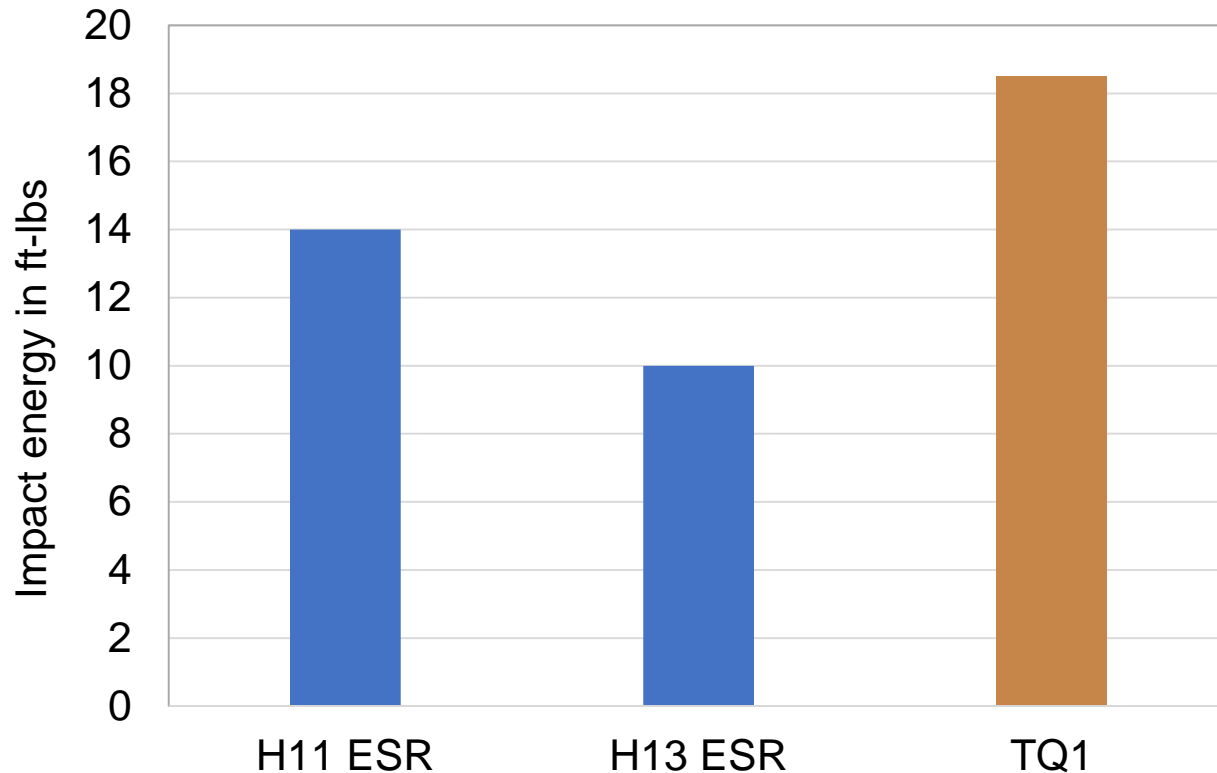
TQ1 reveals better high-temperature strength



- 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

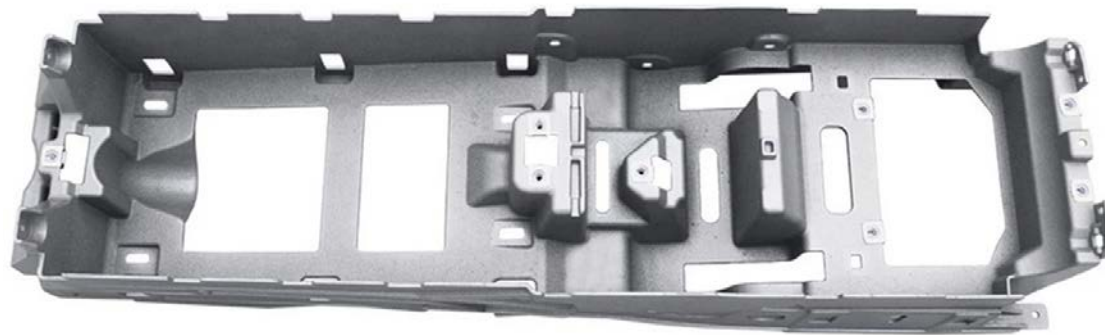
- Compared to H13 TQ1 combines good tempering resistance, improved high-temperature strength and excellent toughness.
- As a result, TQ1 provides excellent thermal shock resistance and cracking resistance. It is therefore suitable for dies with high surface requirements.
- The high toughness level of 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.

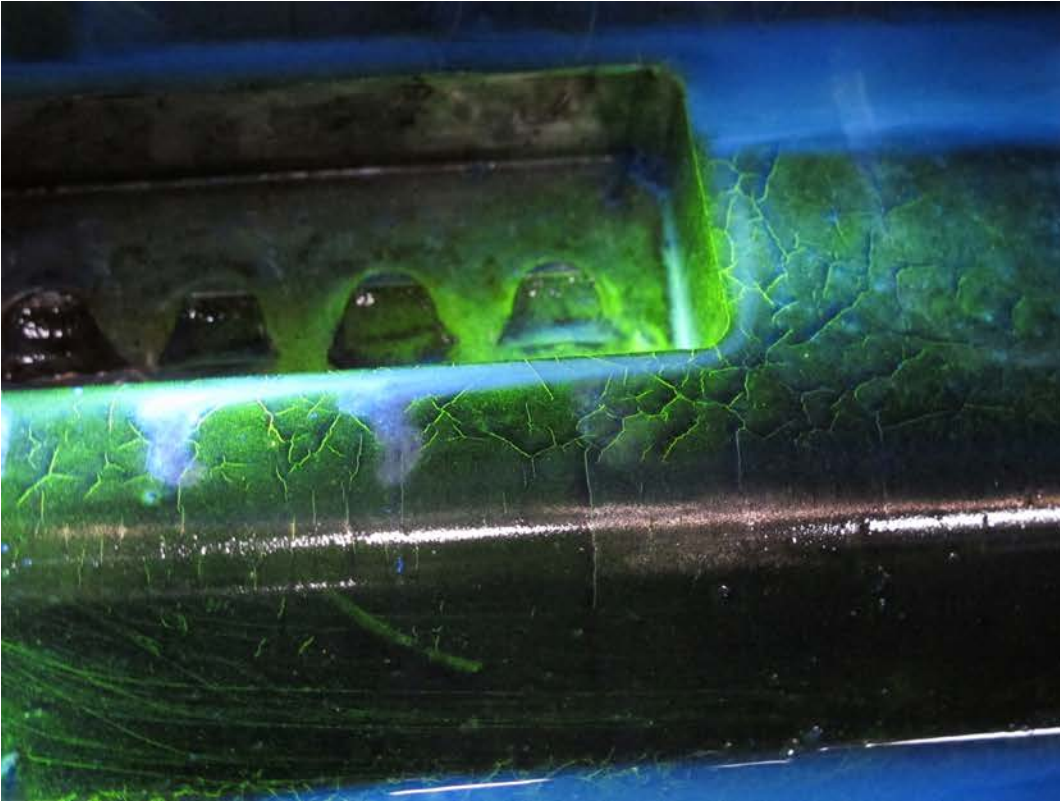
DIE CAST COMPONENTS WITH ULTRA-HIGH SURFACE REQUIREMENTS

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

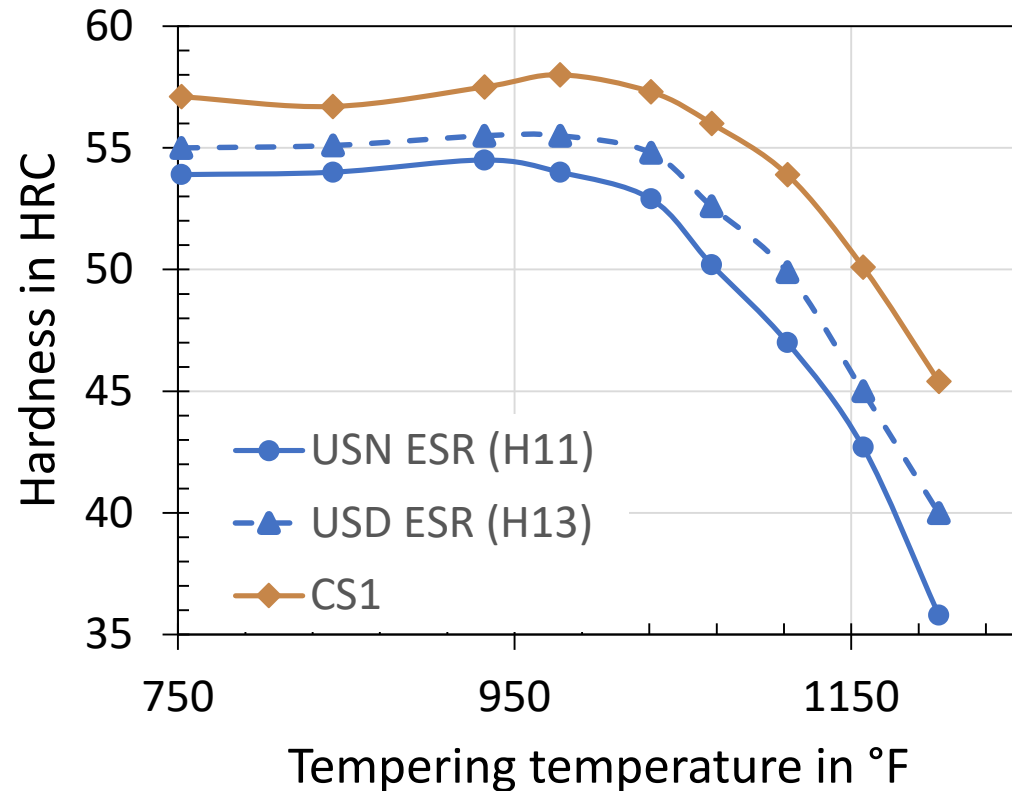


Alloy concept of CS1 optimized for toughness at elevated hardness

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	+

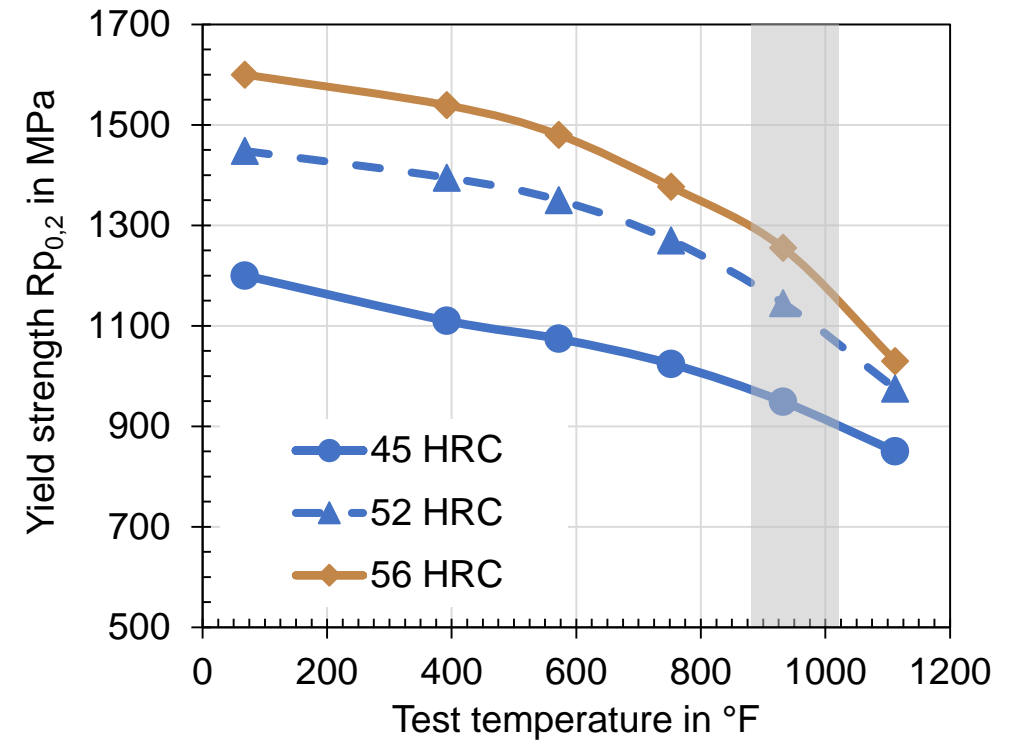
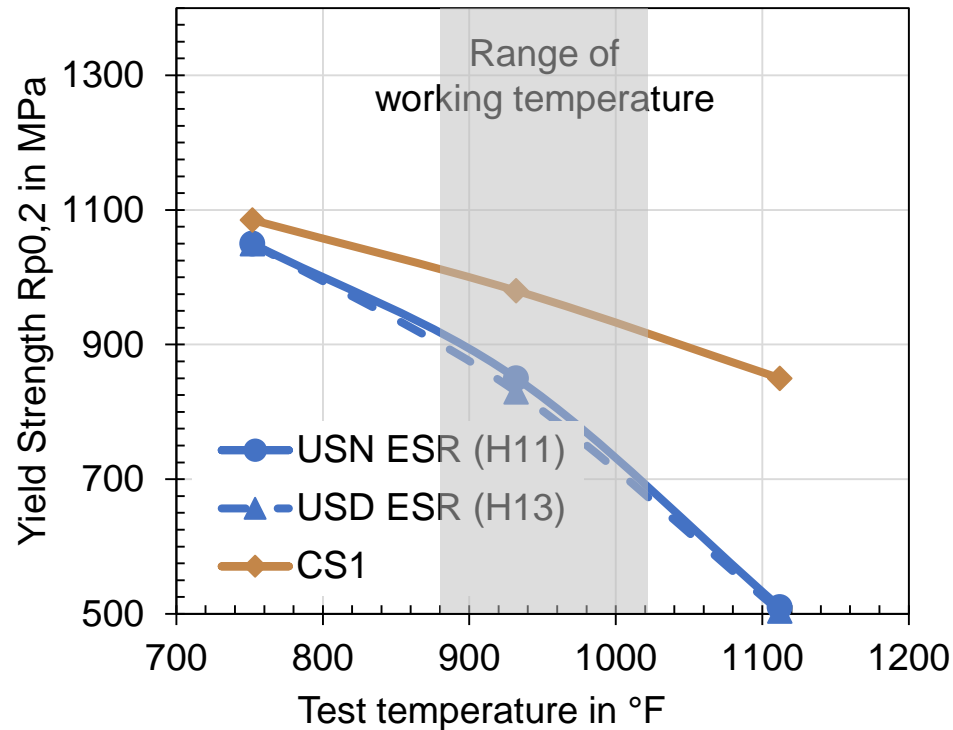
- Higher carbon for hardness and wear resistance (carbides)
- Mo for improved hardenability and high-temperature strength
- Nb dose to support grain refinement thus toughness
- Lowest levels of undesired trace elements

CS1 provides elevated hardness and improved tempering behavior



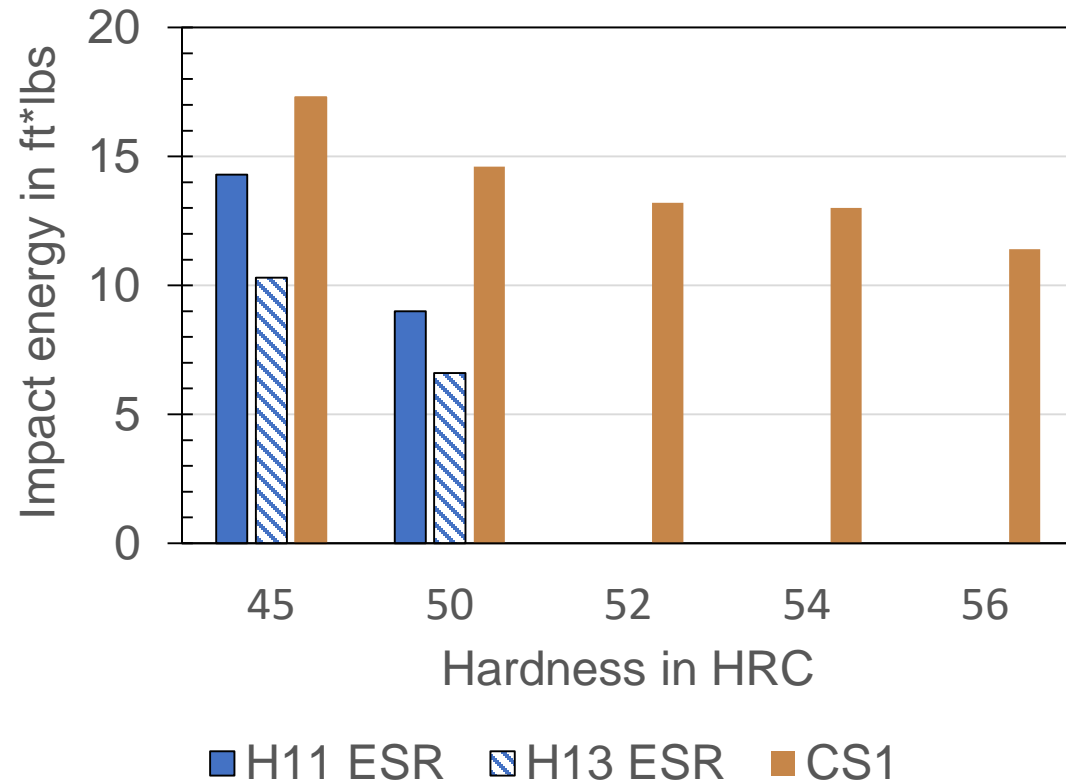
- Higher secondary hardness maximum compared to H11 and H13.
- Improved tempering resistance compared to H11 and H13.

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



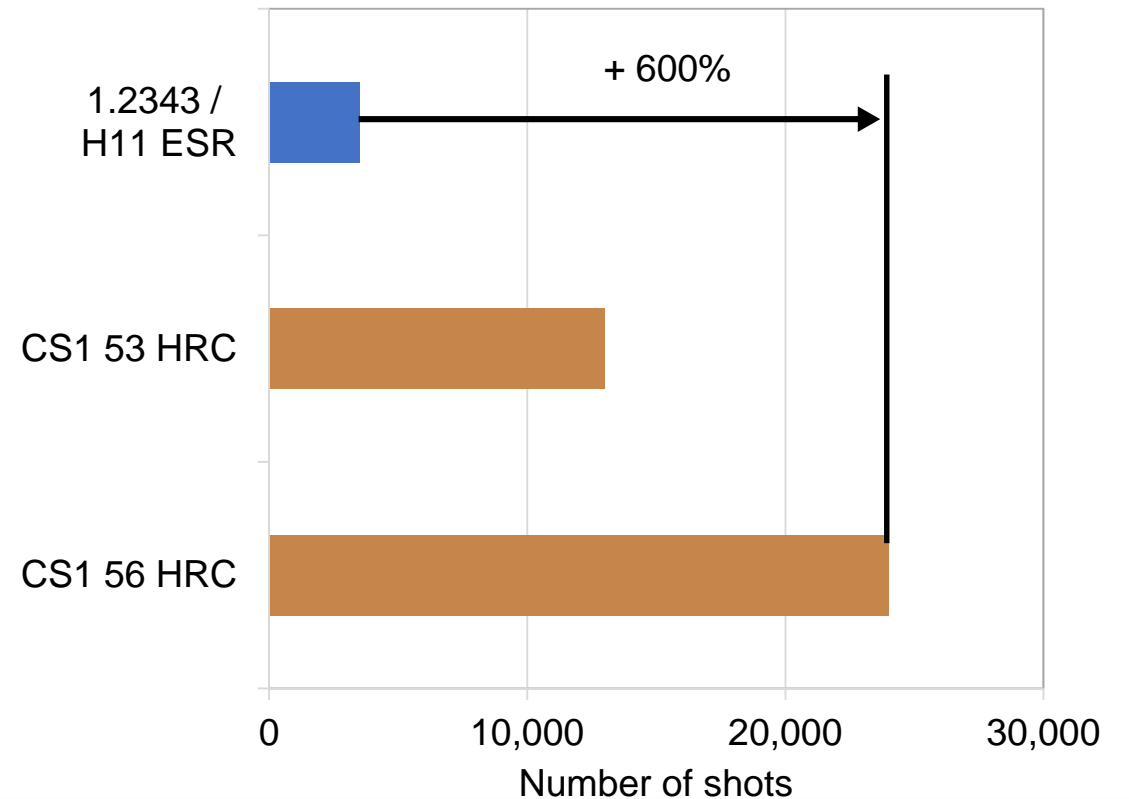
- CS1 offers an improvement of impact toughness by more than 20 % compared to H11 and H13.
- ISO-V-notch samples taken from the center of forged bars (short transverse).
- H11, H13 (45 HRC) acc. to NADCA #207-2018



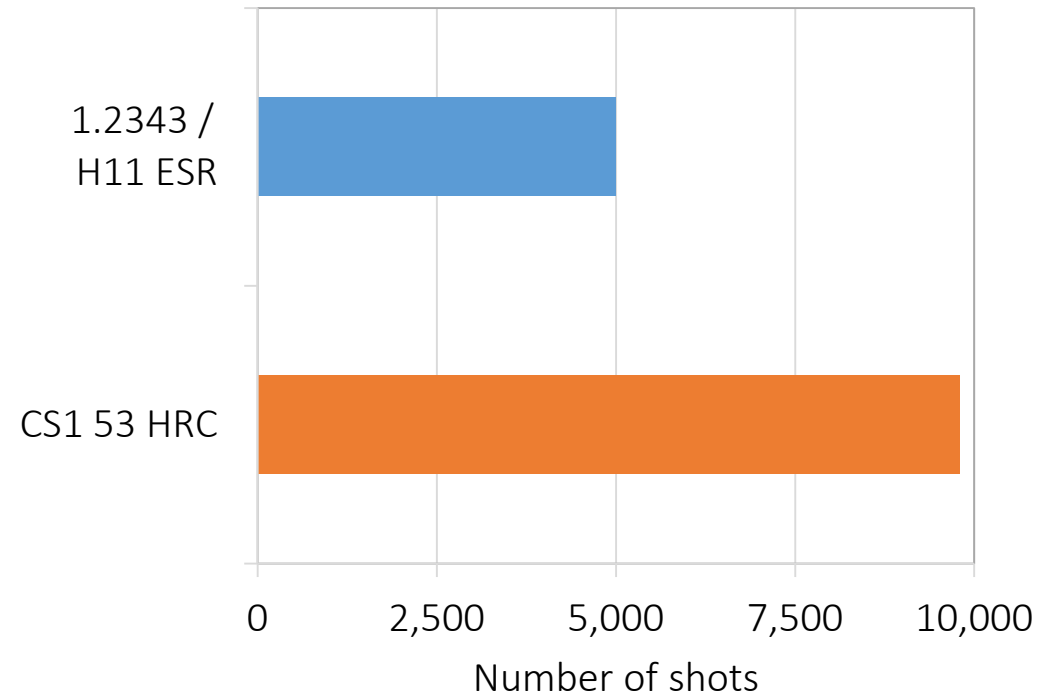
CS1 leads to significant improvement of die performance

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 \pm 1	H11 ESR mod.	47 \pm 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 \pm 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 \pm 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!

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