SIAM YAMATO STEEL

Reduction of Longitudinal Crack in Beam Blank Casting

SYS Smart Surface

Agenda

- SYS Company profile & Manufacturing process introduction
- Observation & Understanding “Longitudinal crack”
- Analysis
- Actions
- Check result

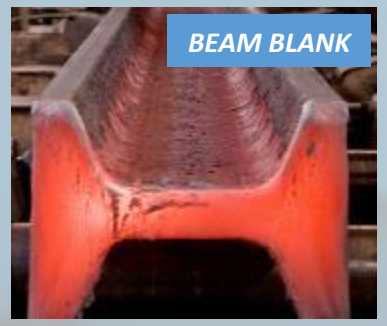
Company profile

SYS I
- Capacity: 600,000 ton per year
- Established: 1992
- Started Production: 1994
- Location: Maptaphut Industrial Estate, Thailand

SYS II
- Capacity: 500,000 ton per year
- Established: 2006
- Started Production: 2010
- Location: WHA Eastern Industrial Estate, Thailand

"SYS Steel you can trust"

Steel Plant Products

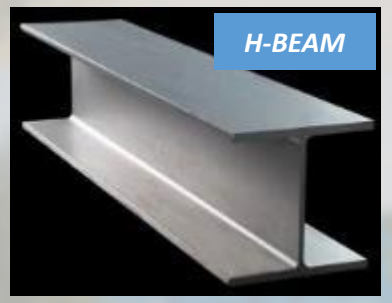


2 Sizes

8 Sizes

2 Sizes

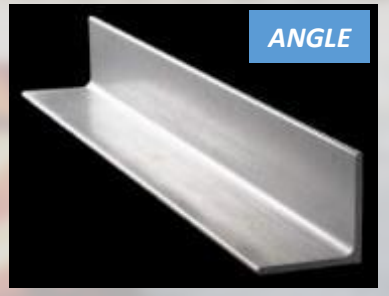
Rolling Mill Products



H100x50 to H900x300

I150x75 to I600x190

C100x50 to C380x100



L100x100 to L250x250

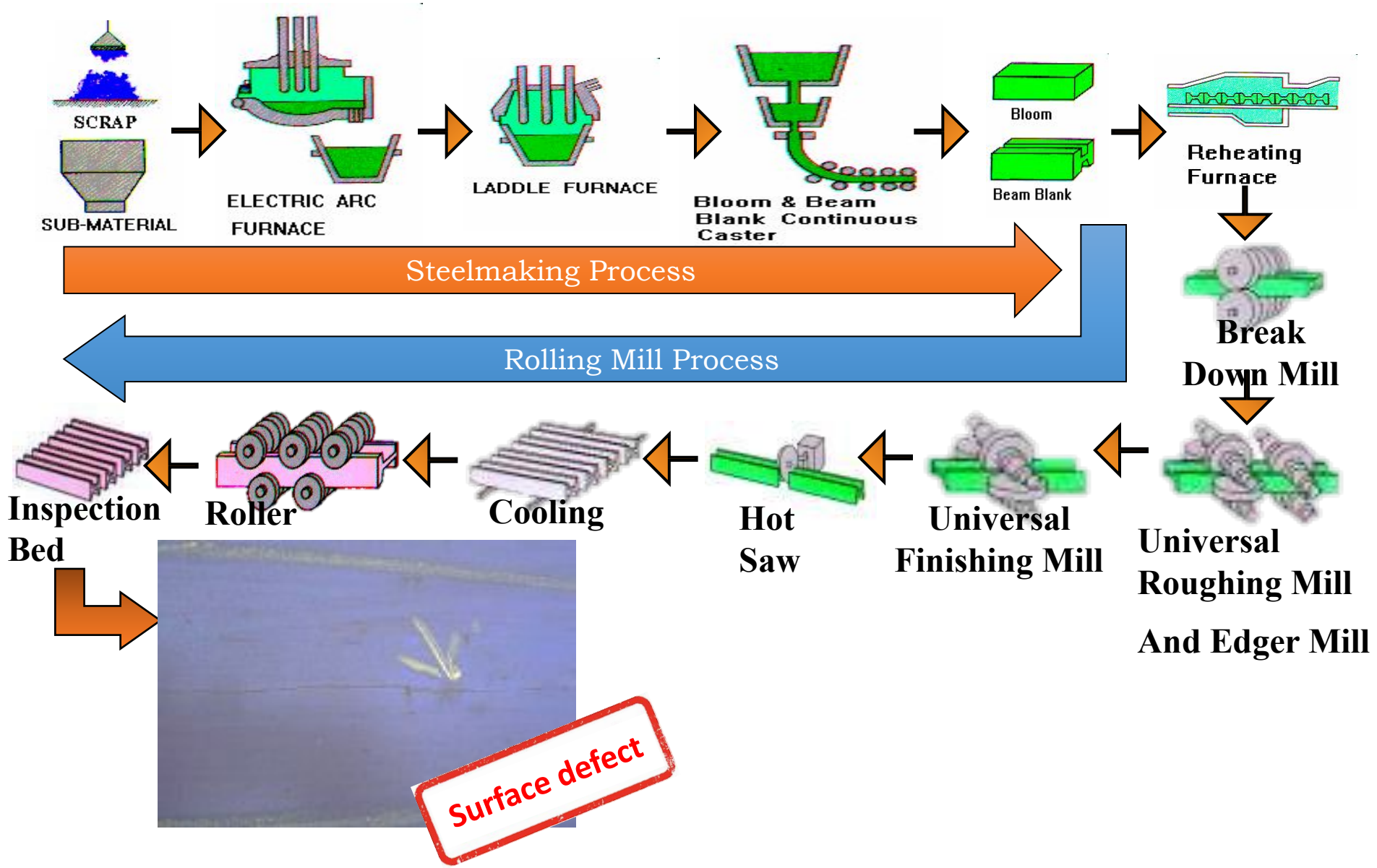
SP400x100 to SP400x170

50x50 to 450x300

Company profile

“SYS Steel you can trust”

Manufacturing process



What is longitudinal crack?

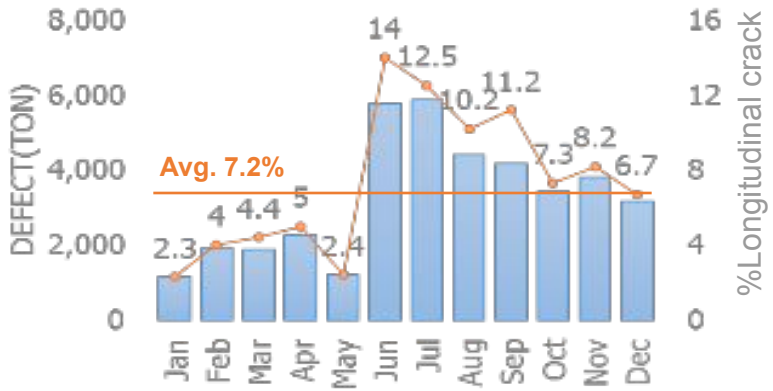
Surface crack ,The main factors causing the occurrence of surface cracks in the shell of the beam blanks during continuous casting

“This defect is fairly common for beam blanks”

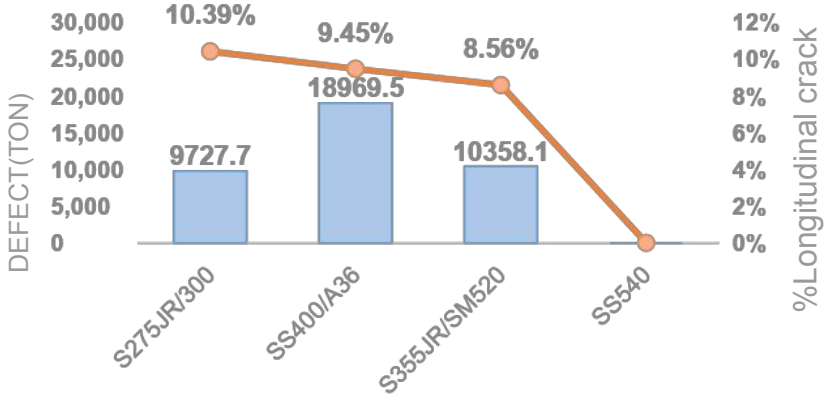
Ref. Madias, J., Genzano, C., Oropeza, M., and Moss, C., “A Review of defects in beam blank casting and the measures proposed for their elimination”

Longitudinal crack record

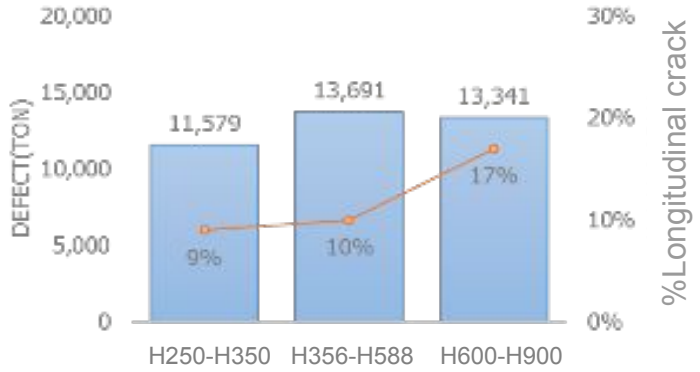
- Month



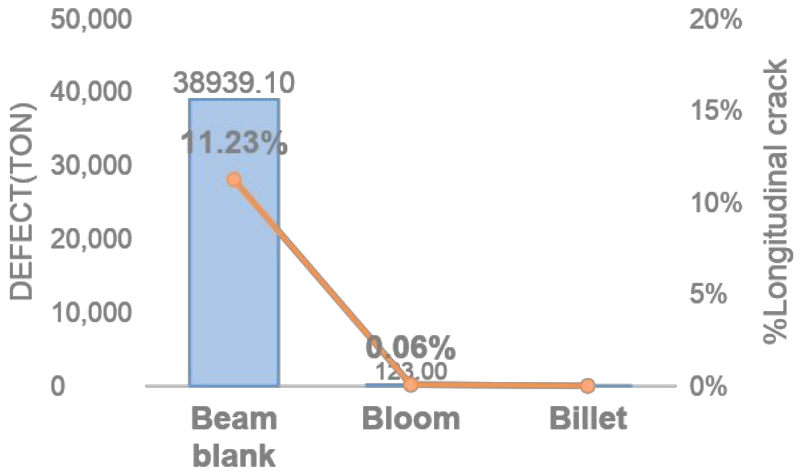
- Grade



- Product size



- Beam blank/Bloom



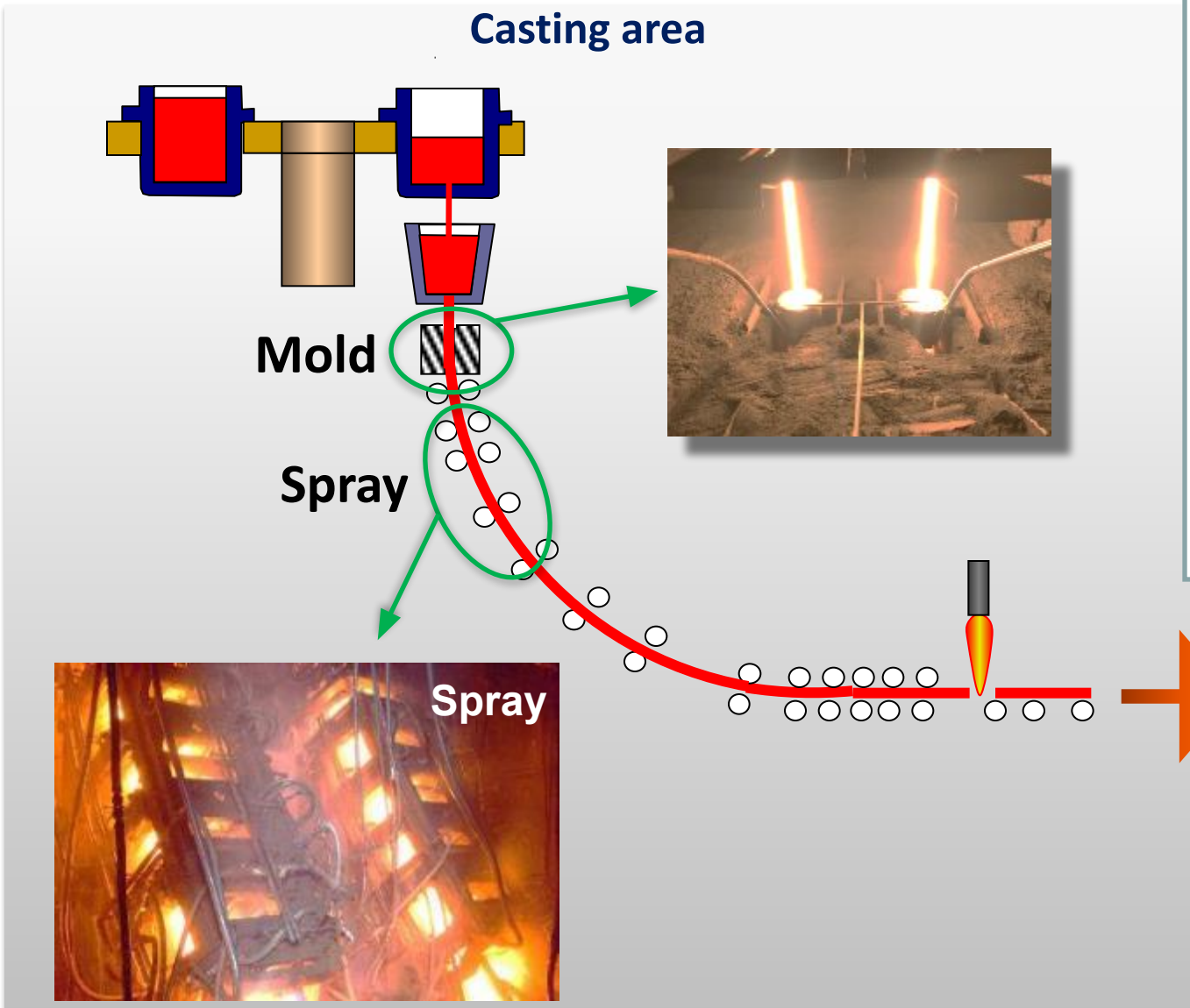
Beam Blank

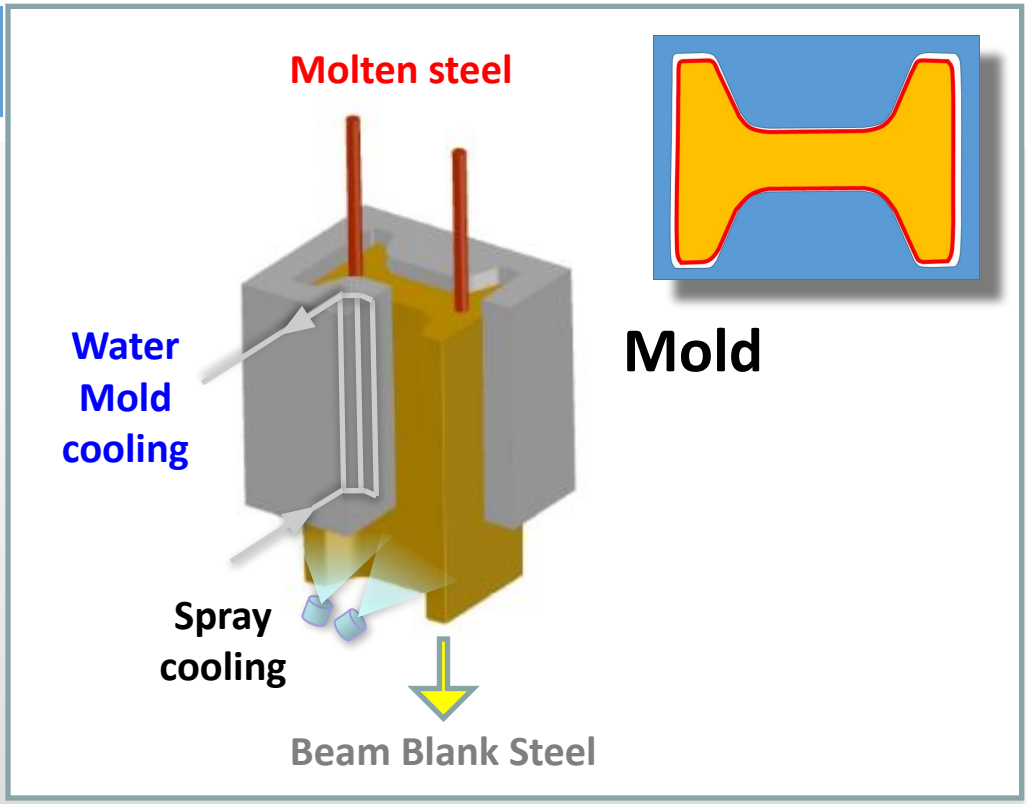
Depth of Longitudinal crack 2mm

H Beam

Depth of Longitudinal crack 0.5mm

Casting process overall



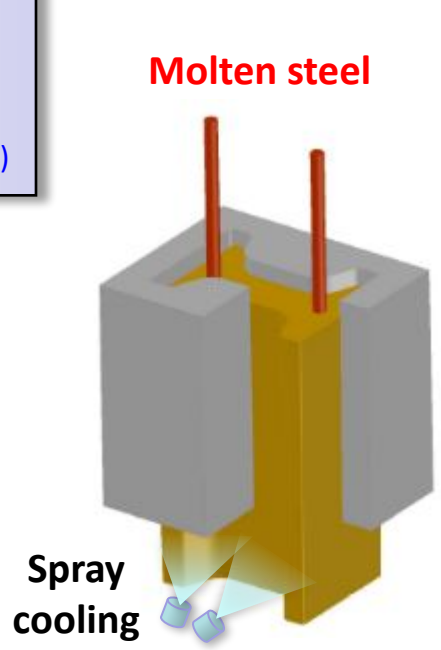


phenomenon

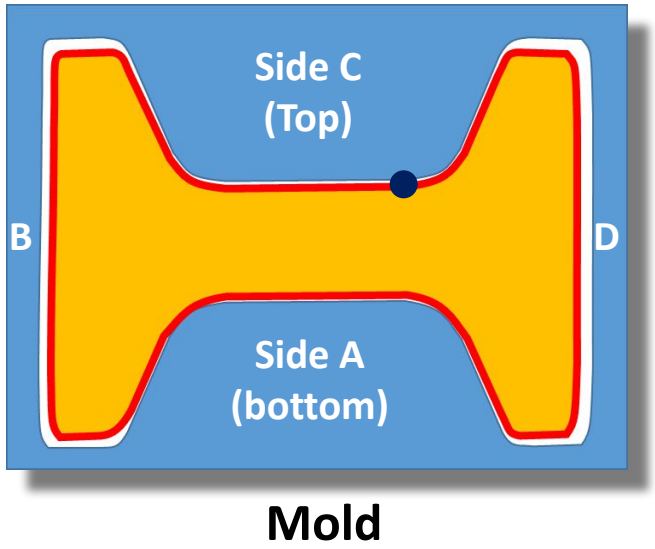
WHY 1

Crack on beam blank

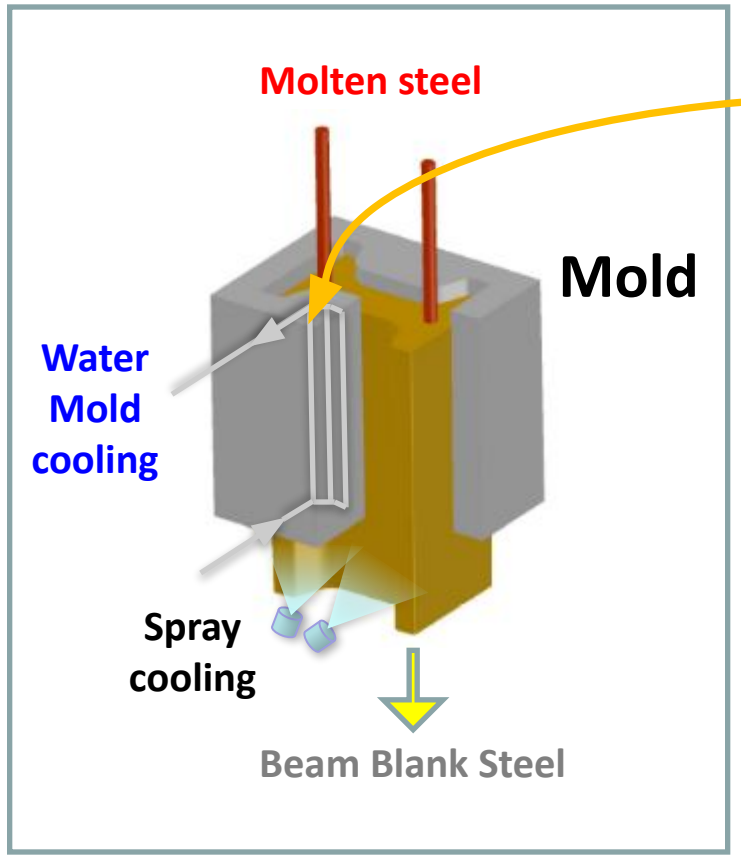
- Low strength of shell layer
- Some force act to shell layer
  (Bigger than strength of shell layer)

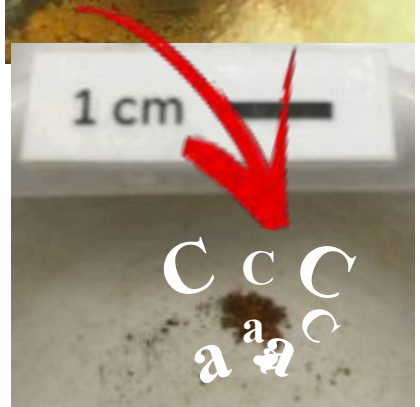


Mold

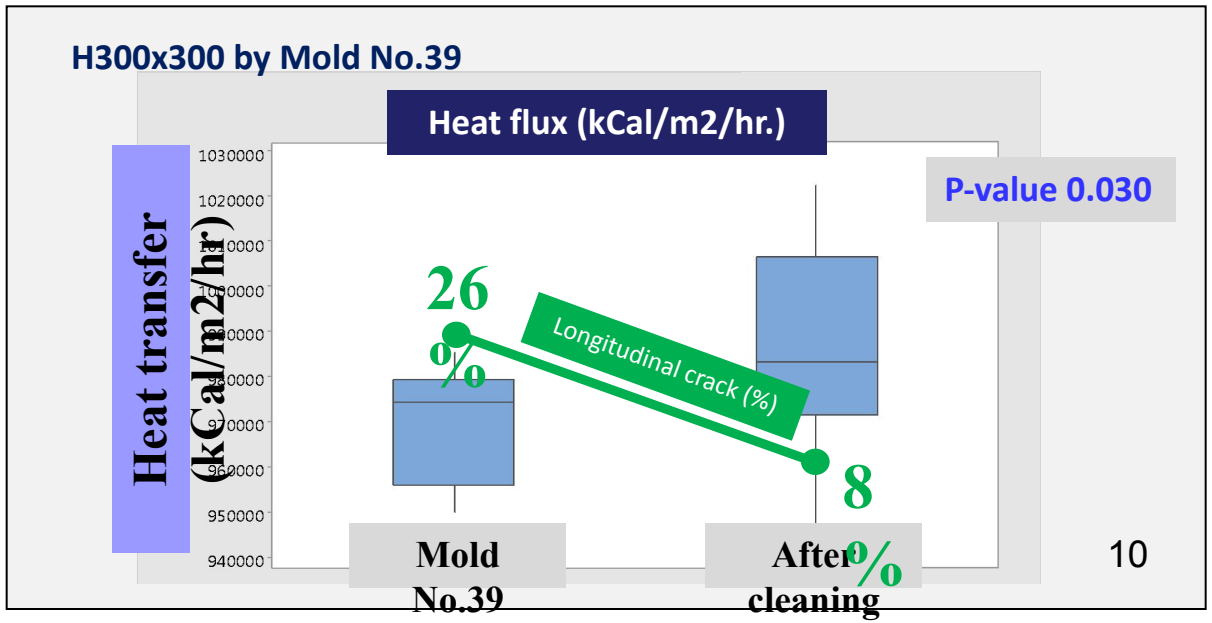


phenomenon	WHY 1	WHY 2	WHY 3	WHY 4
Crack on beam blank	Low strength of shell layer	Thin shell layer	Low heat exchange	Low ability of heat exchange of mold ✓





The thermal conductivity of Ca Scale is about 1/300 compare to Cu

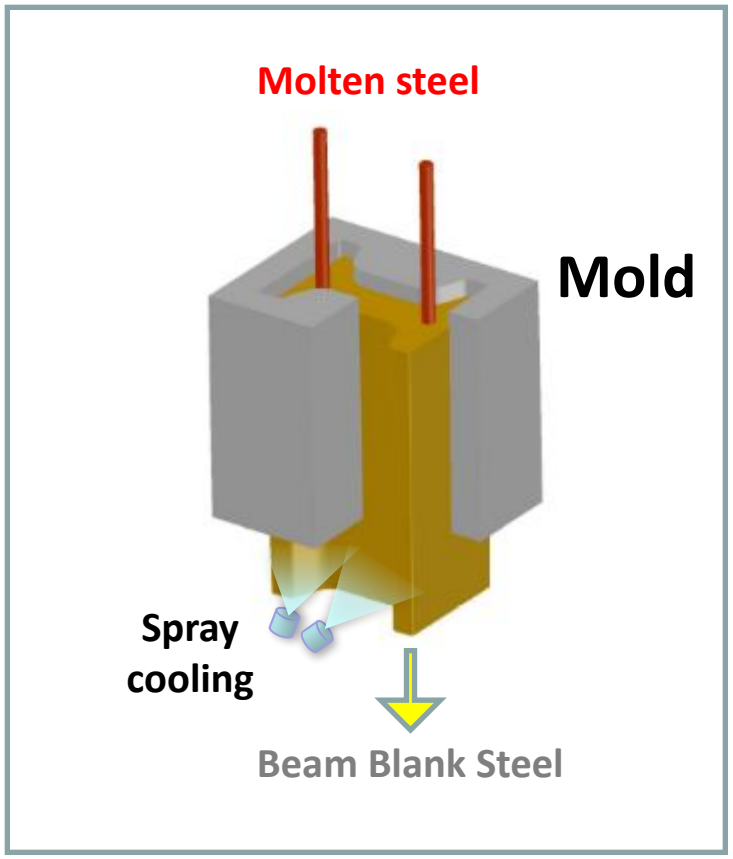


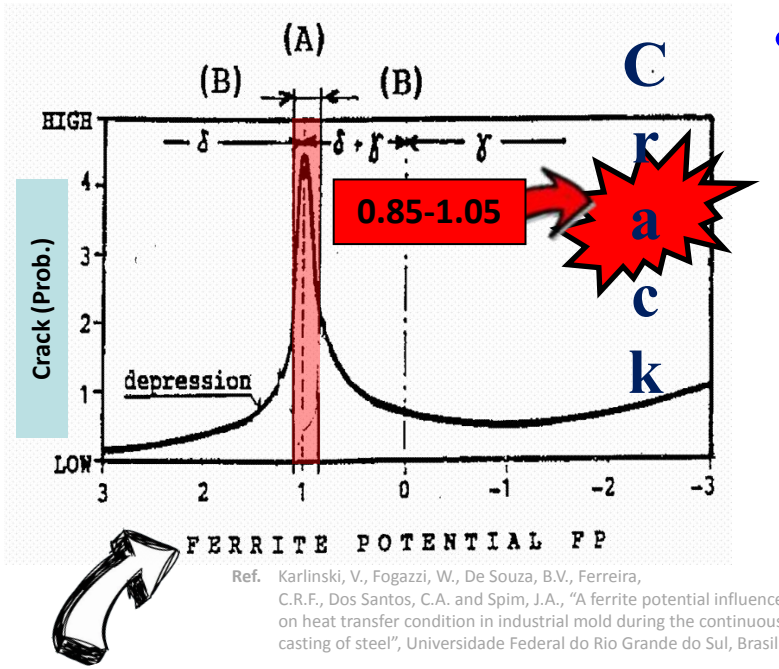
phenomenon | **WHY 1** | **WHY 2**

Crack on beam blank — Low strength of shell layer — Chemical is not appropriate

??

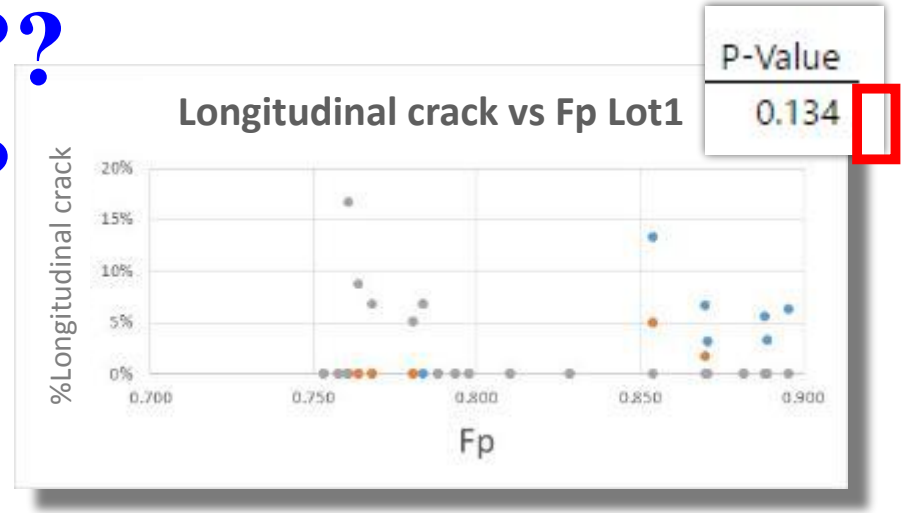
?

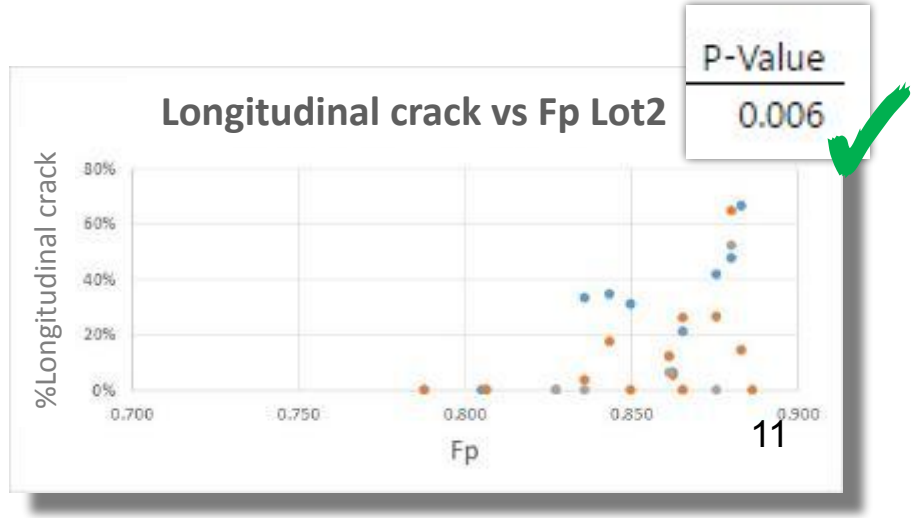




Ref. Karlinski, V., Fogazzi, W., De Souza, B.V., Ferreira, C.R.F., Dos Santos, C.A. and Spim, J.A., "A ferrite potential influence on heat transfer condition in industrial mold during the continuous casting of steel", Universidade Federal do Rio Grande do Sul, Brasil

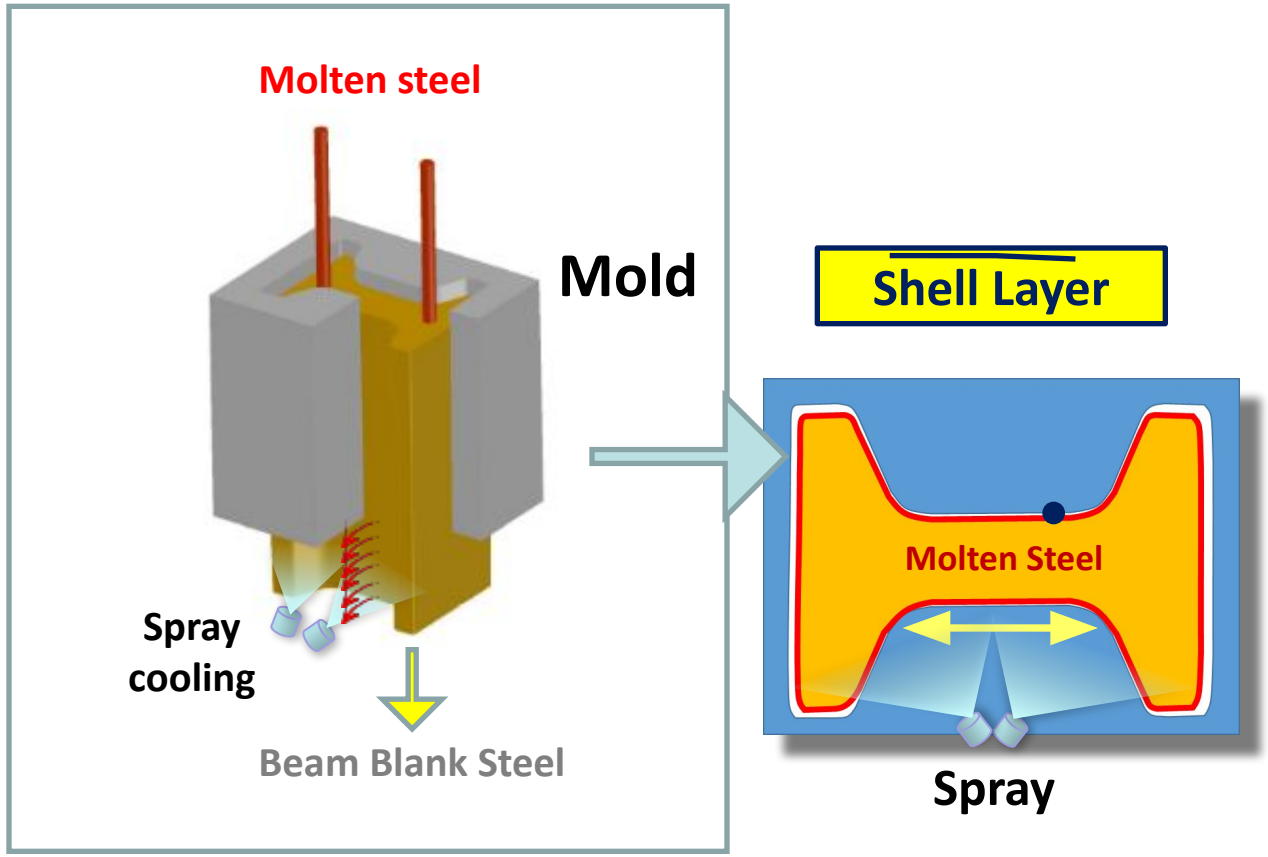
%C+%Mn+%Ni+%Si+%Cr+%Mo



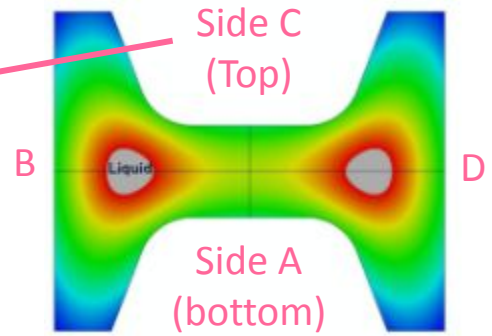


phenomenon	WHY 1	WHY 2	WHY 3
Crack on beam blank	Some force act to shell layer (Bigger than strength of shell layer)	Too much Contraction force	Too much water spray cooling

??



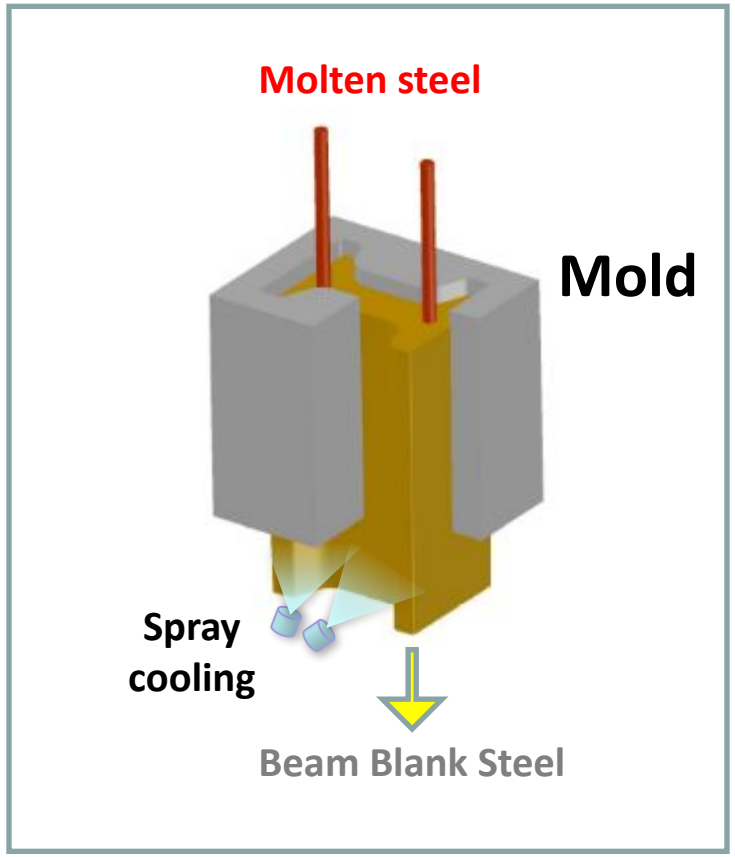
?

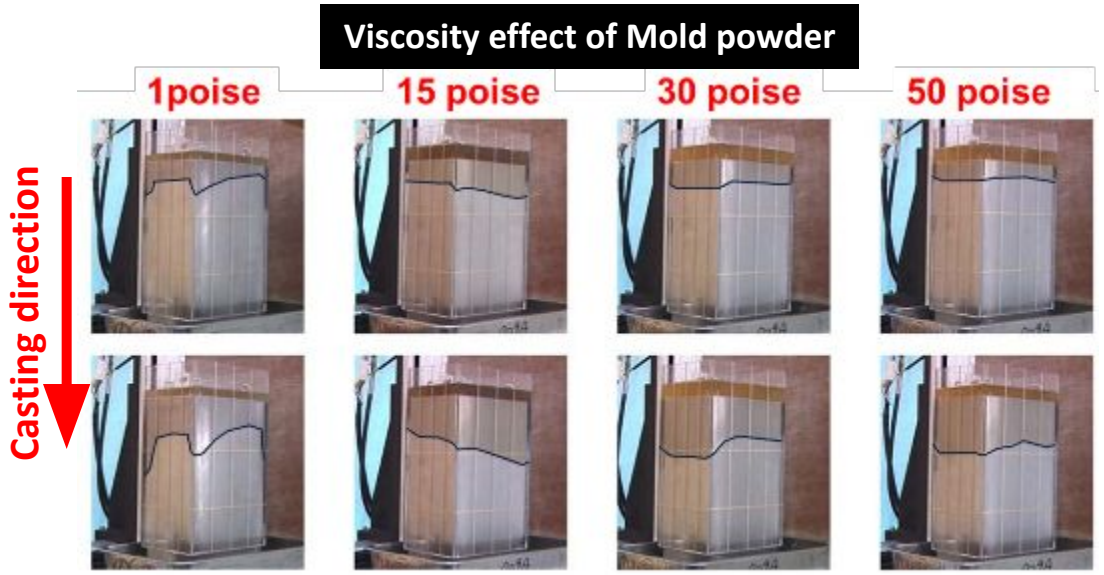


Actual temp was not much different from expected

Problem observation | Analysis | Action | Check result

phenomenon	WHY 1	WHY 2	WHY 3	WHY 4
Crack on beam blank	Some force act to shell layer (Bigger than strength of shell layer)	Too much Contraction force	Too much water spray cooling	??
		Unbalance contraction force	Ununiformed lubrication film of mold powder	? Low viscosity of mold powder ?? ?





Chemical is not appropriate ?? ? Too much water spray cooling ?? ? Low viscosity of mold powder ?? ?

DOE Experiment

Factors

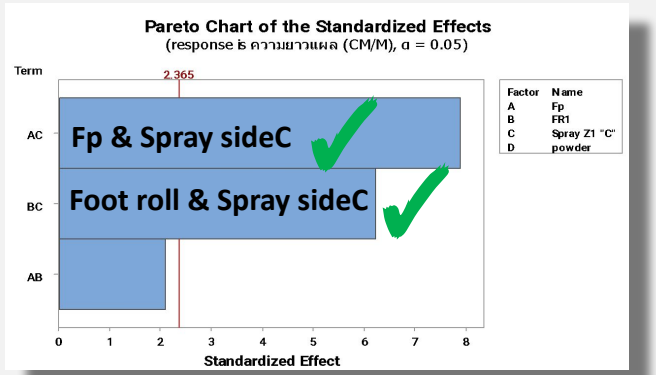
Fp Min : 0.80
Medium : 0.85
Max : 0.90

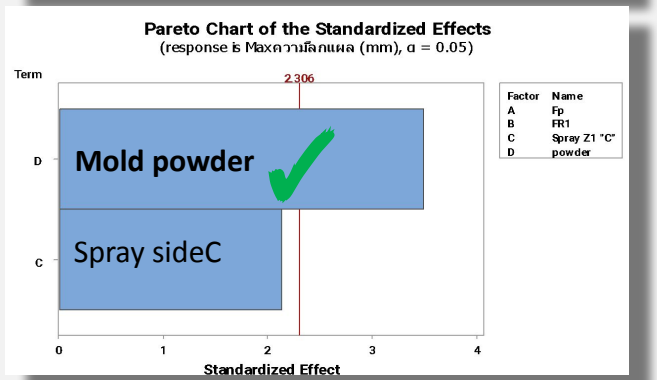
Spray Foot roll
Min : 37 l/min
Medium : 46 l/min
Max : 55 l/min

Spray water side "C"
Min : 40 l/min
Medium : 48 l/min
Max : 55 l/min

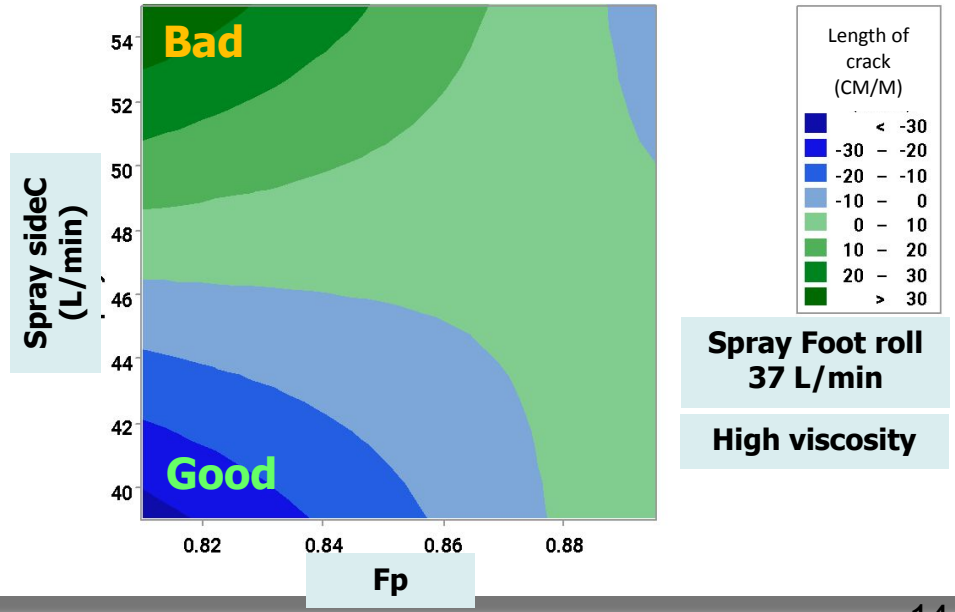
Mold power
High viscosity
Low viscosity

Interaction testing result





Contour Plot result



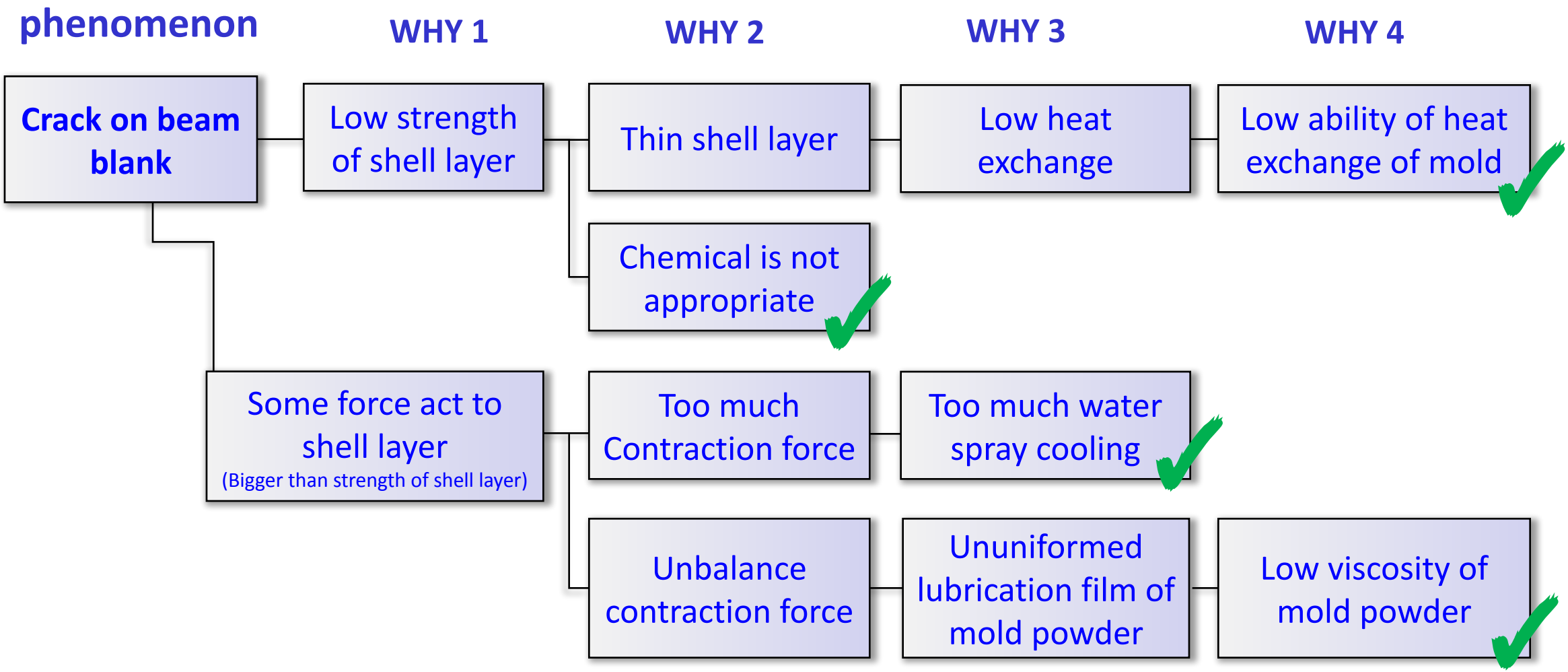
Chemical is not appropriate ✓

Too much water spray cooling ✓

Low viscosity of mold powder ✓

Best condition from DOE

-Mold powder High viscosity
-Foot roll 37 l/min
-Spray segment1 side C 40 l/min
-Fp value ≤ 0.85


phenomenon
WHY 1
WHY 2
WHY 3
WHY 4
Crack on beam blank
Low strength of shell layer
Thin shell layer
Low heat exchange
Low ability of heat exchange of mold
Chemical is not appropriate
Some force act to shell layer
(Bigger than strength of shell layer)
Too much Contraction force
Too much water spray cooling
Unbalance contraction force
Ununiformed lubrication film of mold powder
Low viscosity of mold powder

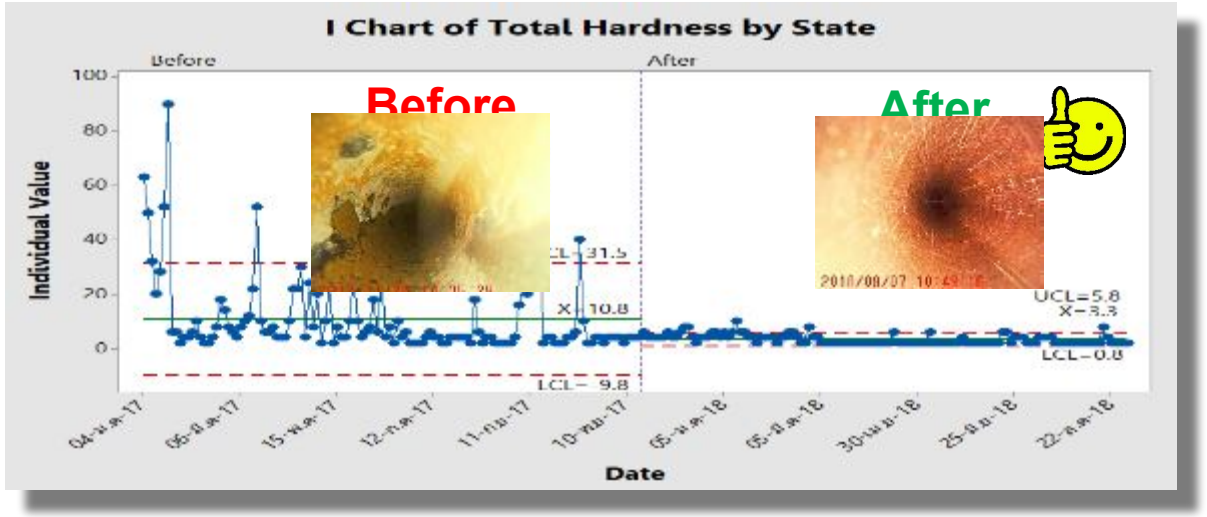
Actions

Problem observation | Analysis | Action | Check result

Phenomenon	WHY 1	WHY 2	WHY 3	WHY 4
Crack on beam blank	Low strength of shell layer	Thin shell layer	Low heat exchange	Low ability of heat exchange of mold ✓

Action#1

Ca hardness check sheet



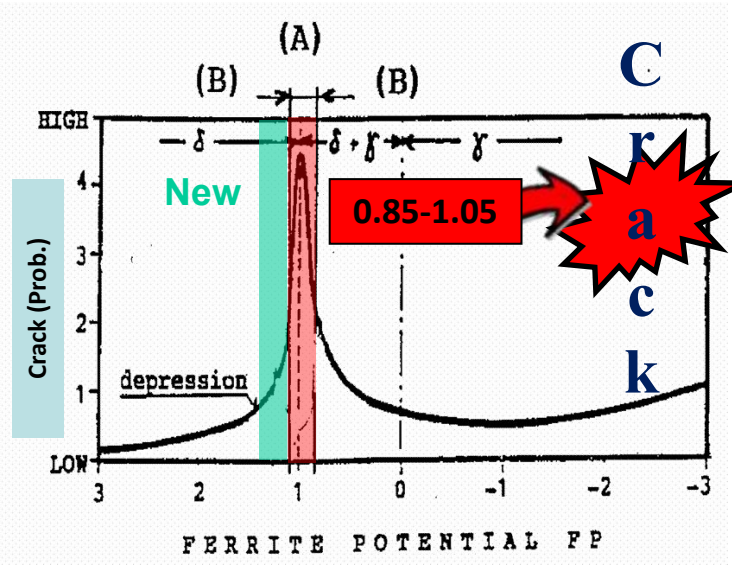
Action: Control Mold cleaning schedule ≤250 Heat

Reduce & Control Ca hardness in Water mold cooling ≤10 ppm by additional softener

Phenomenon	WHY 1	WHY 2
Crack on beam blank	Low strength of shell layer	Chemical is not appropriate ✓

Action#2

Fp calculation

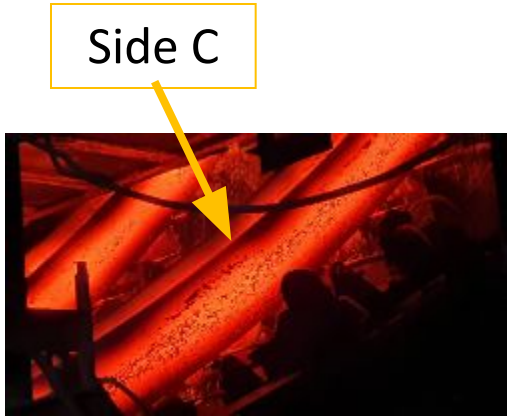


Action: Set parameter Fp ≤0.85 via control C, Mn, Ni, Si, Cr and Mo

Problem observation | Analysis | Action | Check result

Phenomenon	WHY 1	WHY 2	WHY 3
Crack on beam blank	Some force act to shell layer (Bigger than strength of shell layer)	Too much Contraction force	Too much water spray cooling ✓

Action#3



Action: Adjust spray cooling pattern in HMI

- **Foot roll spray 35-39 L/min** (From DOE)
- **Spray side C 37-43 L/min** (From DOE)

Phenomenon	WHY 1	WHY 2	WHY 3	WHY 4
Crack on beam blank	Some force act to shell layer (Bigger than strength of shell layer)	Unbalance contraction force	Ununiformed lubrication film of mold powder	Low viscosity of mold powder ✓

Action#4

Chemical Composition (%)	Aim	Range
SiO_2	46.5	45.5 - 47.5
Al_2O_3	4.3	3.8 - 4.8
CaO	27.9	26.9 - 28.9
Na_2O	1.4	0.9 - 1.9
F	1.9	1.4 - 2.4
Li_2O	0.9	0.4 -1.4
B_2O_3	3.0	2.5 – 3.5
T.C	9.8	9.3 – 10.3
CaO/SiO_2	0.60	0.55 - 0.65
Softening Point (℃)	1085	1070 – 1100
Viscosity(Pa·S)at 1300℃	2.5	2.3 – 2.7
(poise) at 1300℃	25	23 – 27

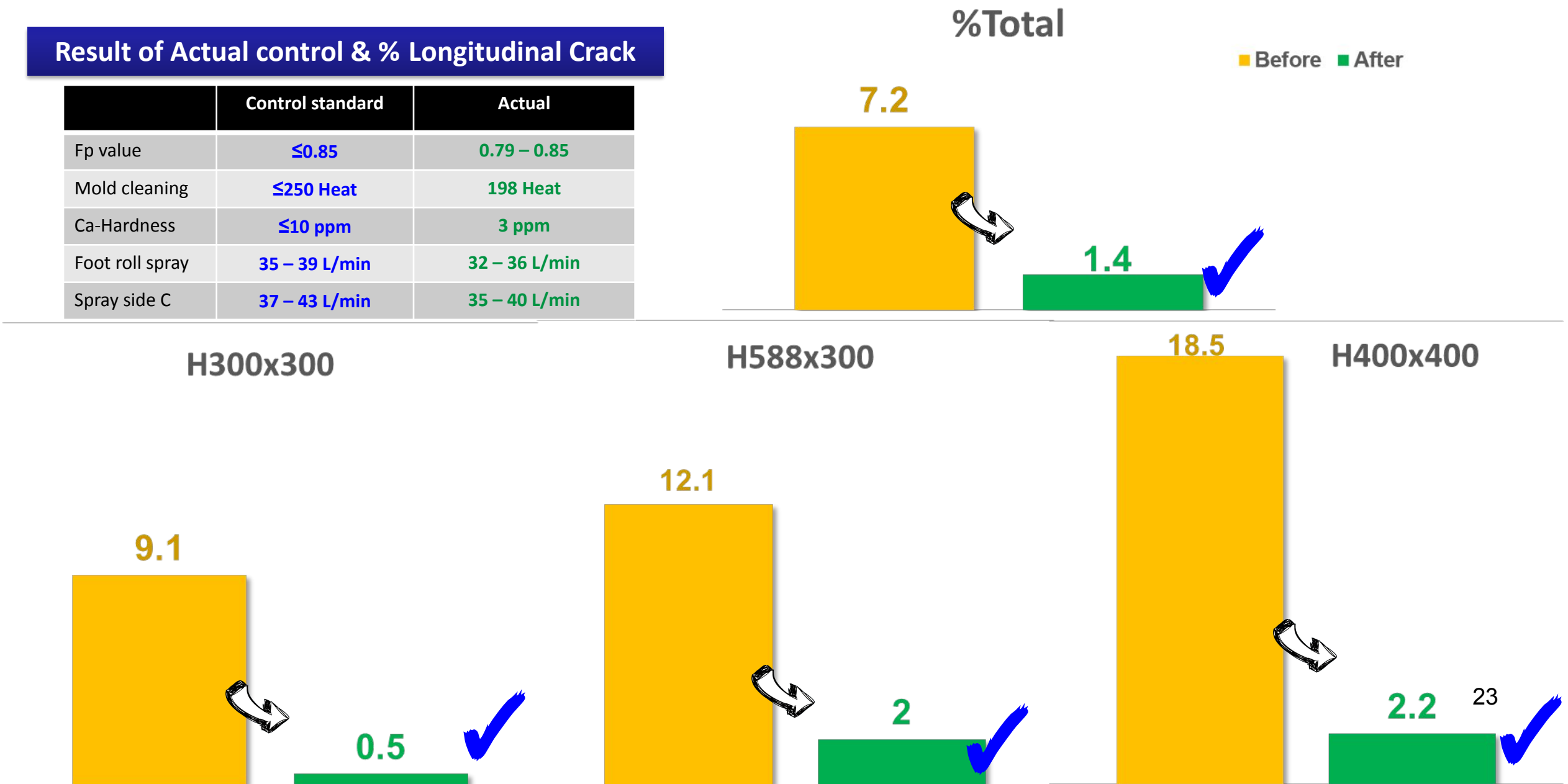
Material specification

Action: Set Spec. Mold powder in high viscosity

Check result

Result of Actual control & % Longitudinal Crack

	Control standard	Actual
Fp value	≤0.85	0.79 – 0.85
Mold cleaning	≤250 Heat	198 Heat
Ca-Hardness	≤10 ppm	3 ppm
Foot roll spray	35 – 39 L/min	32 – 36 L/min
Spray side C	37 – 43 L/min	35 – 40 L/min



Siam Yamato Steel

Thank you

“SYS Steel you can trust”