7. dgfs Fachtagung

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The influence of a one layer solution on the anchoring system

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calderys

TABLE OF CONTENT

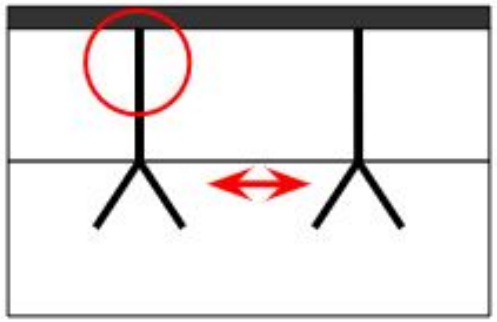
01 background

background

- **Initial goal: Development of a technical solution to minimize the stress for the anchoring system**
- **Influenced by:**
  - **Technical and construction based requirements**
  - **Corrosion caused by secondary fuels**

background

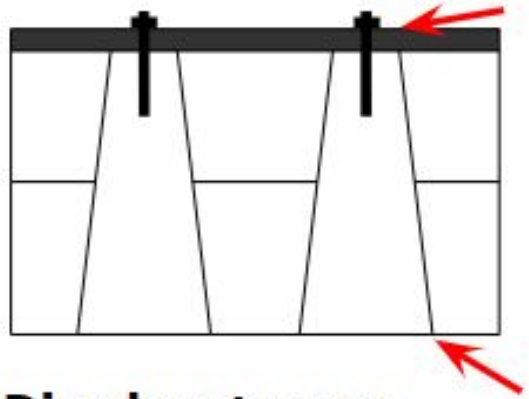
background



Steel

Insulation

Dense Castable



- **Disadvantages:**
  - Shearing of the anchors due to movement of front layer
  - Corrosion of alloy caused by falling below the dew point in cooler sections

- **Disadvantages :**
  - Separation of front layer by circular joints
  - Fixed connection to steel shell

background

- **Mechanical load:**
  - Expansion / Shrinkage of material
    - Friction, Spalling
  - Infiltration by Salts & Fumes into the Materials Structure
    - Formation of New Minerals
    - Enrichment of Liquid Phases
    - Structure Changes (Density, Thermal Conductivity)

background

- **Corrosion of Metallic Anchors:**
  - Interface Insulation/Working Lining
    - Shearing of Metallic Anchors
  - Corrosion of Alloys
    - Decrease of Lifetime
  - Below Dew Point attack by Liquids

background

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In most cases a combination of several causes is responsible for the damage of the anchors!!!

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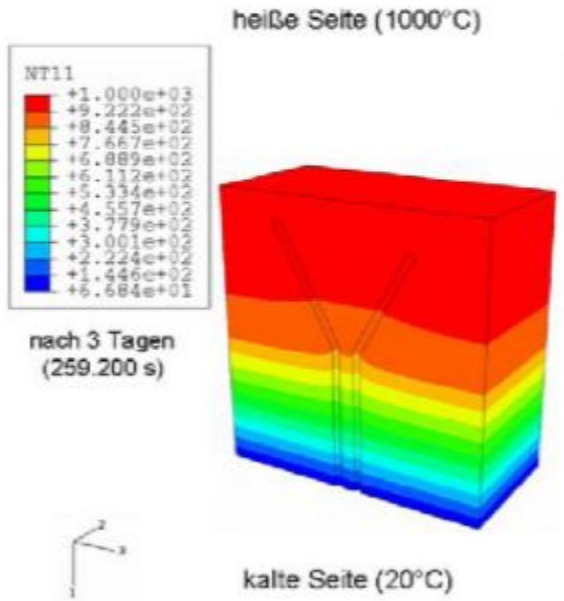
background

- **Influence of Geometry :**

Huge Temperature Gap from 1000 °C
Varying Stress (Expansion)



background

- **Influence of Geometry :**

Huge Temperature Gap from 1000 °C RT
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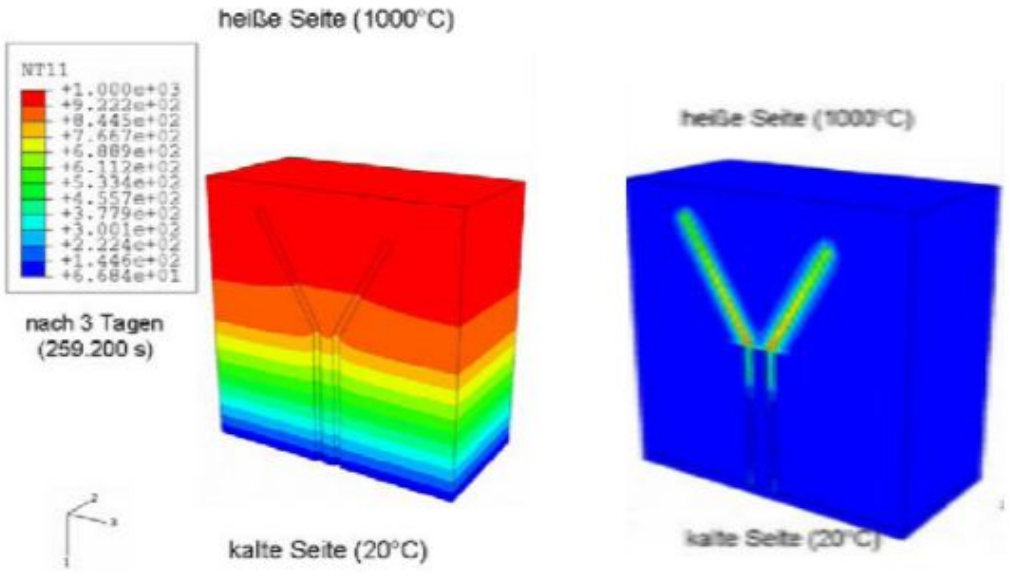
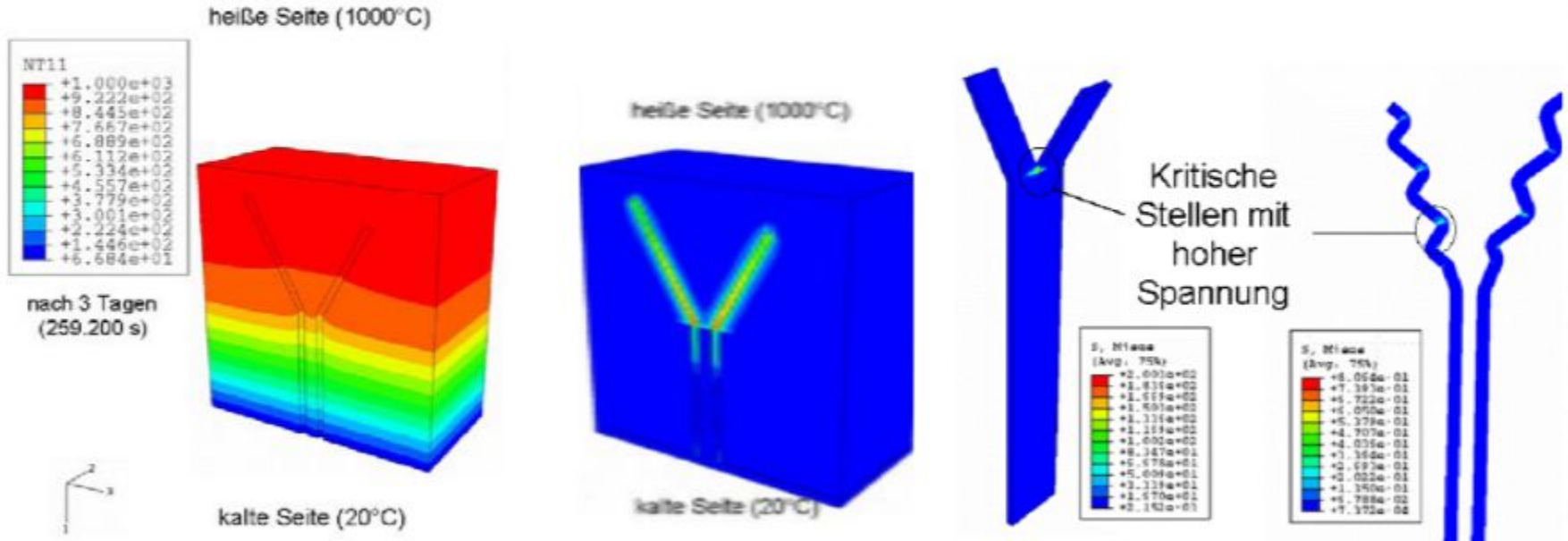


- **Highest Load in Area between Insulation Layer – Front Layer**

background

- **Influence of Geometry :**

Huge Temperature Gap from 1000 °C RT
Varying Stress (Expansion)



- **Highest Load in Area between Insulation Layer – Front Layer**
- **Highest Load in the Bending Radii and in the Anchor Slot**

02 solution

solution

- development of one layer gunning solution
  - alkali resistant
  - high grade of insulation
    - Low thermal conductivity
    - Low density
  - acceptable mechanical properties

- to minimize the stress for the anchoring system
  - linear heat transfer
  - no relative movement between the front and the insulation layer

solution

grain structure

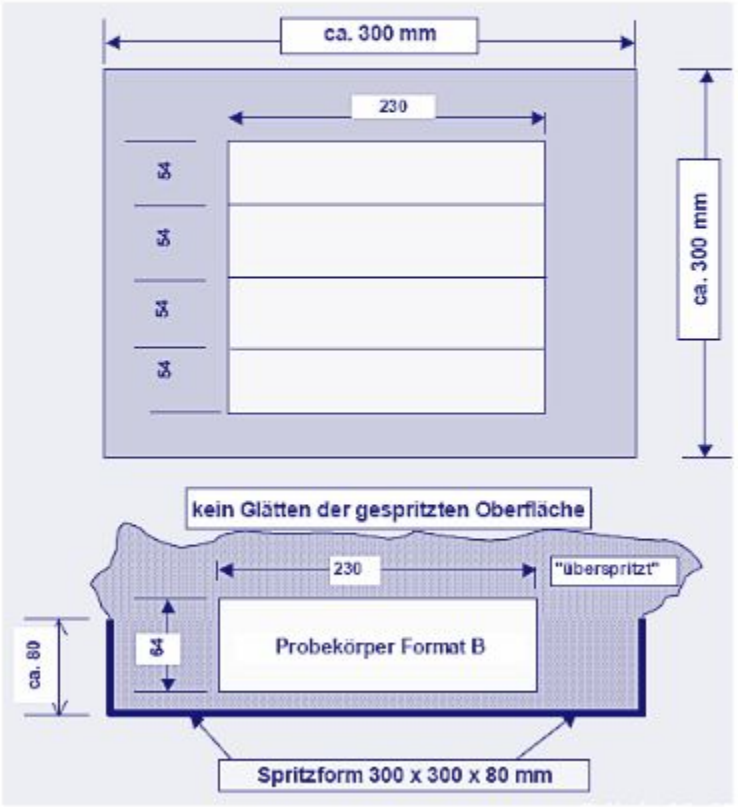
	>3,15 [%]	> 2 [%]	>1 [%]	>0,5 [%]	>0,25 [%]	>0,125 [%]	>0,063 [%]	<0,063 [%]
CALDE® GUN R 50 A	5,0	--	45,0	--	--	--	65,0	35,0

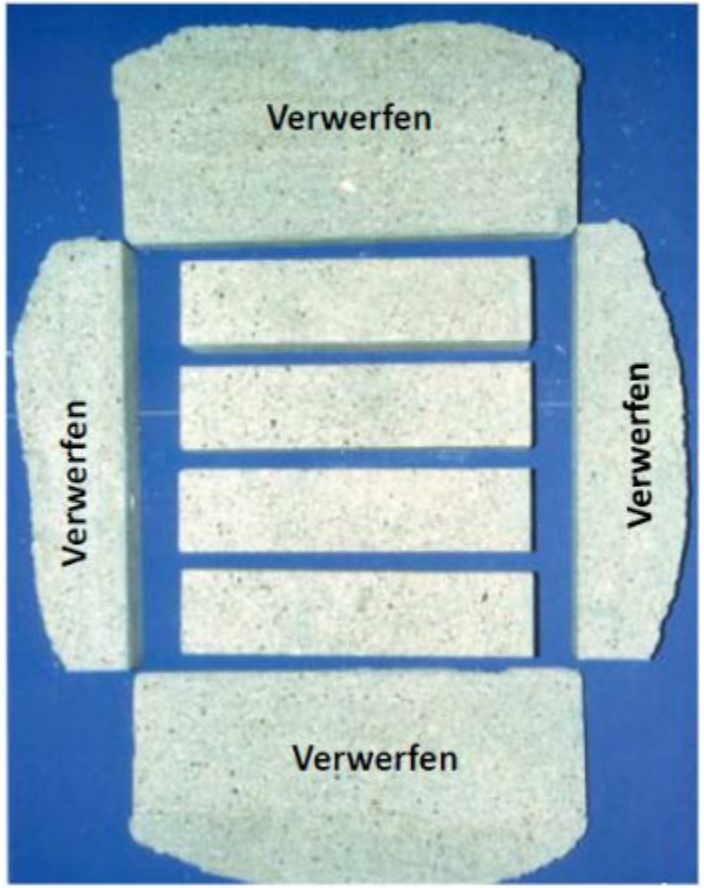
grain analysis

- acid fireclay, grain size up to 3 mm
- fine particles of SiO_2 to increase the alkali resistance
- cement bonded material (calcium aluminate cement)

solution

gunning trial
(samples taken)





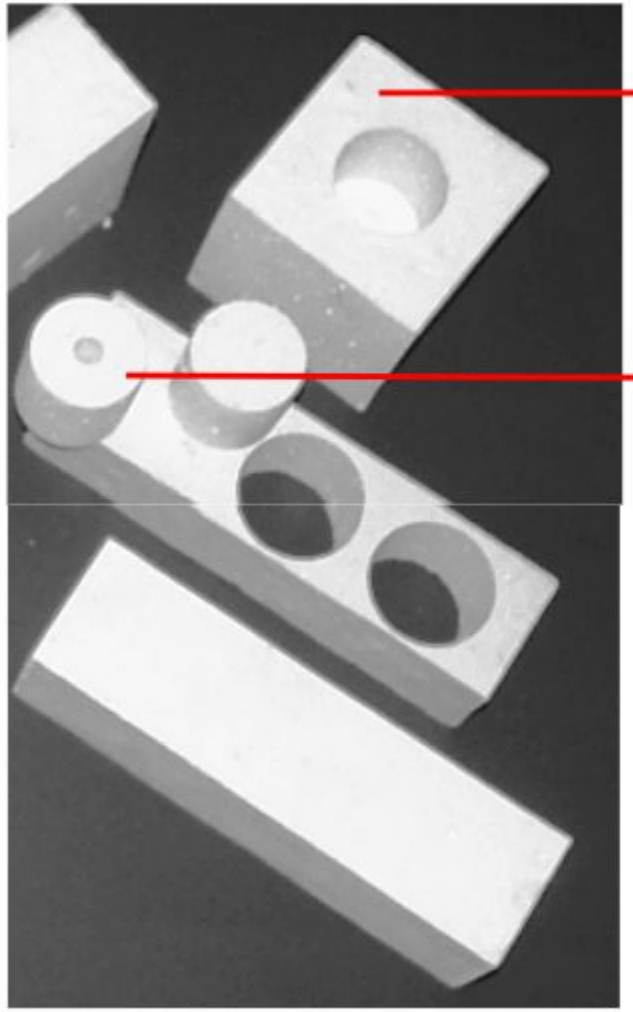
solution

mechanical properties

	permanent linear change *[%]*	MoR *[MPa]*	CCS *[MPa]*	density *[g/cm³]*	open porosity *[%]*
TDS 110°C	-0,02	8,5	55,0	1,97	16,0
TDS 800°C	-0,15	8,0	45,0	1,88	26,5
TDS 1000°C	-0,25	8,0	40,0	1,85	26,5
TDS 1200°C	-0,70	10,0	45,0	1,90	19,0

solution

additional samples taken

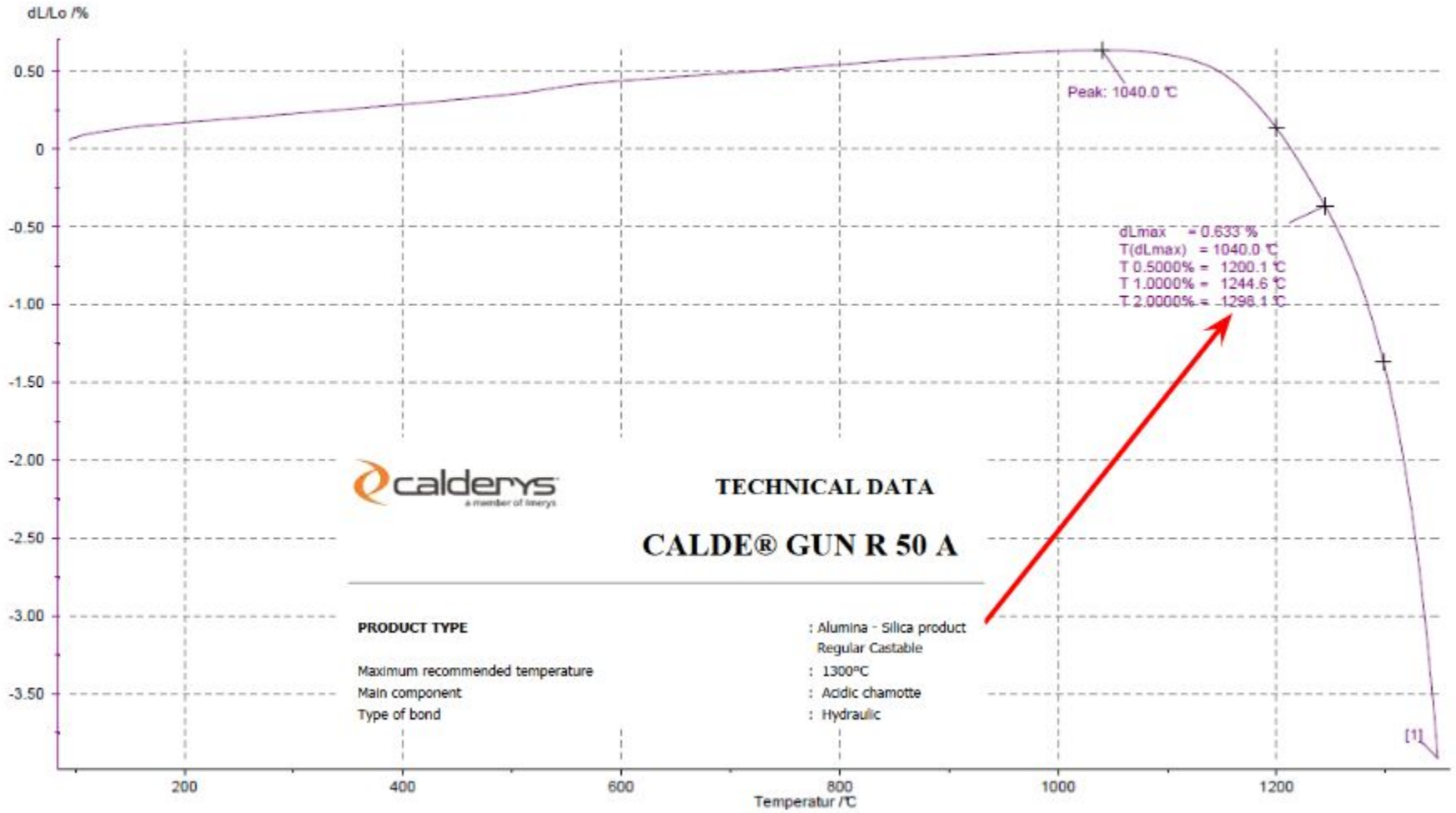


alkali testing
(square with 50 mm hole)

refractoriness under load
(50 mm cylinder)

solution

Refractoriness Under Load



solution, second step

improvement of the mechanical properties

all known materials for a one layer solution are more or less on a low level regarding the mechanical properties
- values between 20 and 45 Mpa (800°C)

we started an investigation in four steps
- step 1
  - main topic
  - identification of different raw materials
- step 2
  - main topic
  - creation of new formulas
- step 3
  - main topic
  - characterisation of the first results
- step 4
  - main topic
  - summary of all steps, new product !

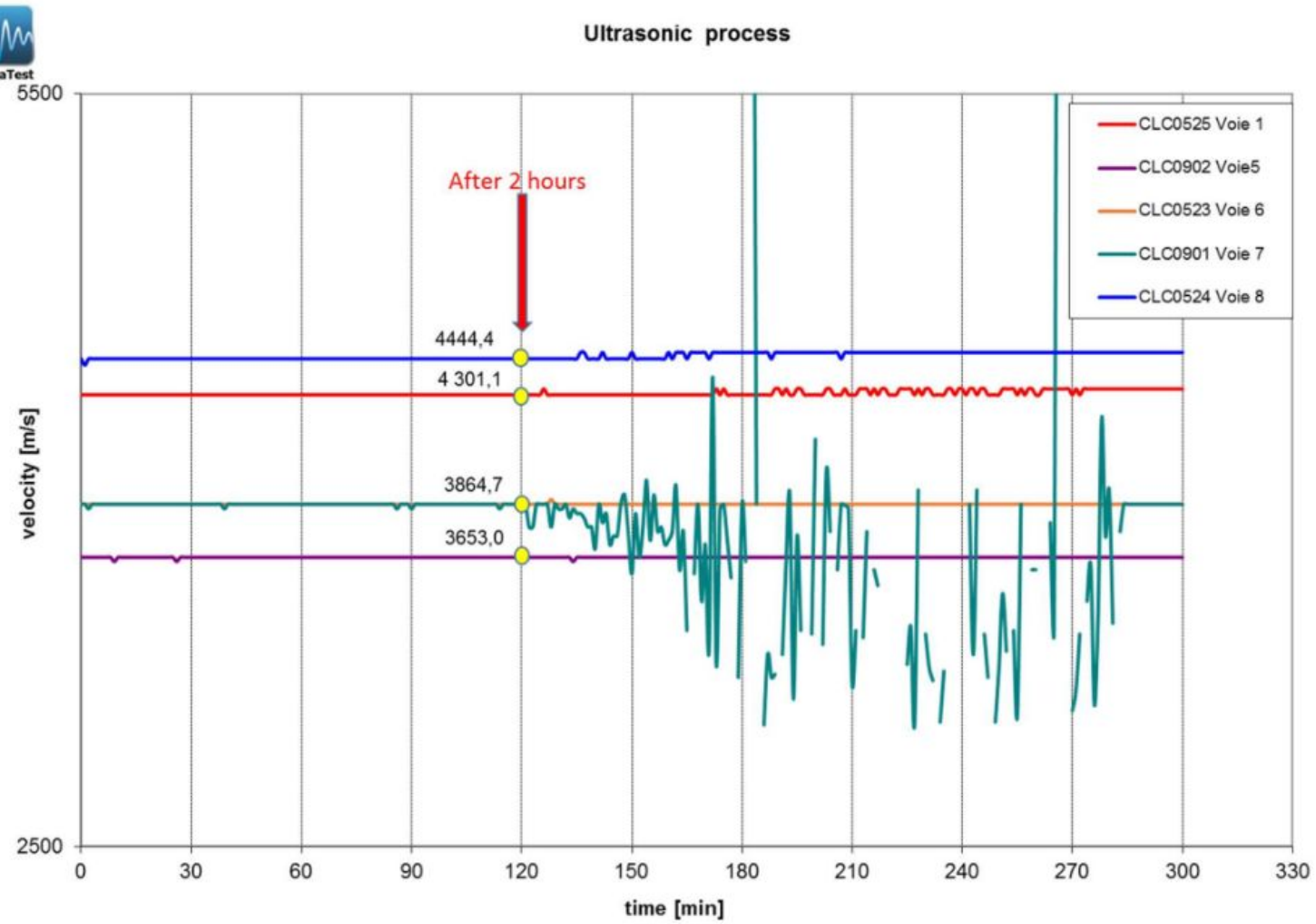
solution, second step

improvement of the mechanical properties

TABLE			CLC0523	CLC0524	CLC0525
Water	%		7	10	9,4
start to be wet	sec		<60	<60	<60
Total mixing time	sec		120	120	120
FLOW TEST	%		A bit difficult to flow. Not enough mixed	Good flowability-Plastic-soft uneder vibrations	Good flowability-Plastic-soft uneder vibrations
Yield	**T/m3**		**2,25**	**1,97**	**2,12**
Stiffening time	min		<120	<120	<120

solution, second step

thermal conductivity



H2O (%)	Yield (t/m3)	VELOCITY (m/s)	Thermal Conductivity from TDS (W/mK)		Thermal Conductivity Theory (W/mK)	
7	2,25	3864	800°C	1,43	800°C	
			1000°C	1,48	1000°C	
10	1,97	4444	800°C		800°C	0,95
			1000°C		1000°C	0,99
9,4	2,1	4301	800°C		800°C	0,83
			1000°C		1000°C	0,87
7 & 26,8	2,25 &	3864	800°C		800°C	
			1000°C		1000°C	
26,8	-	3653	800°C	0,46	800°C	
			1000°C	0,49	1000°C	

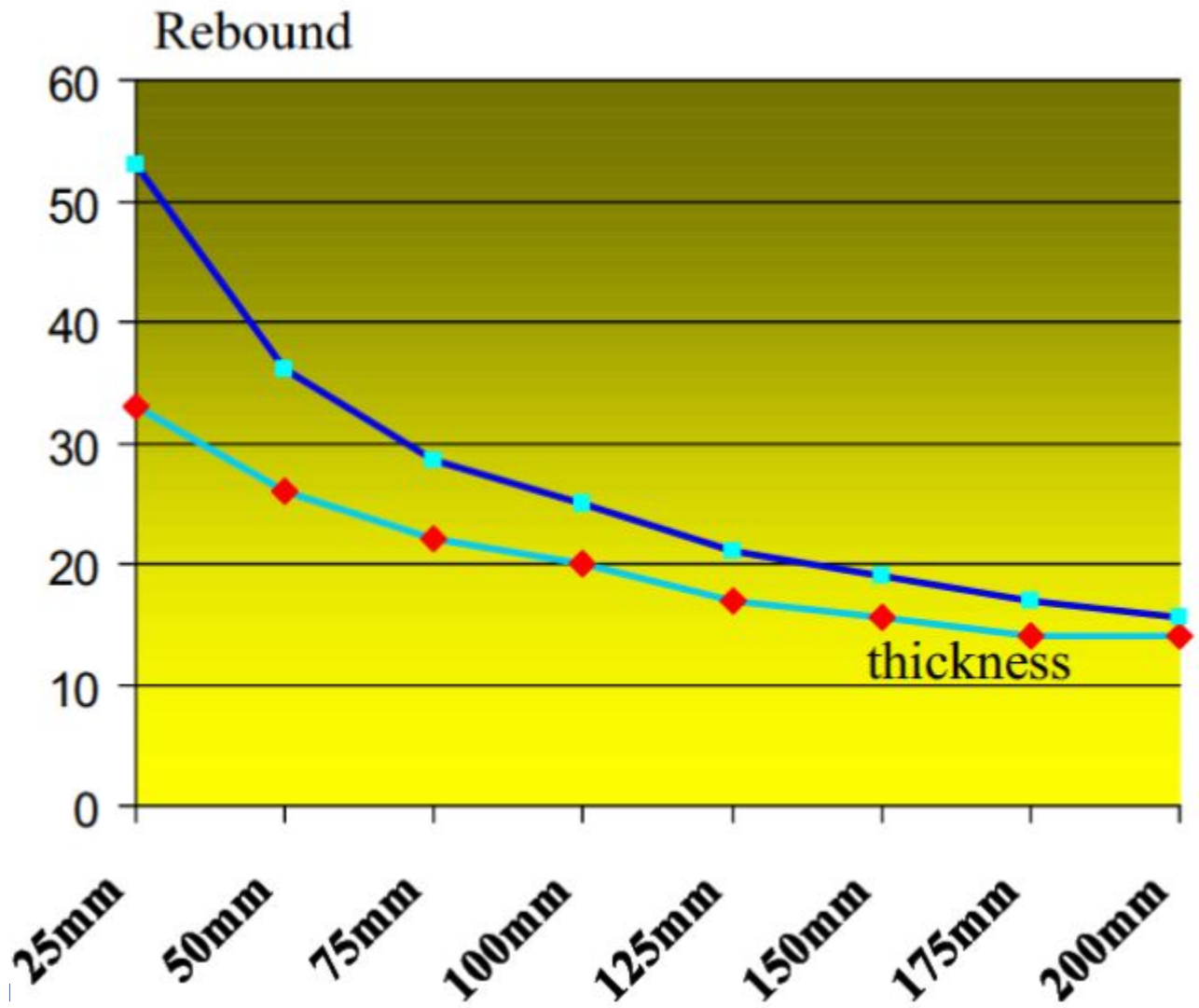
Lorem ipsum

solution, second step

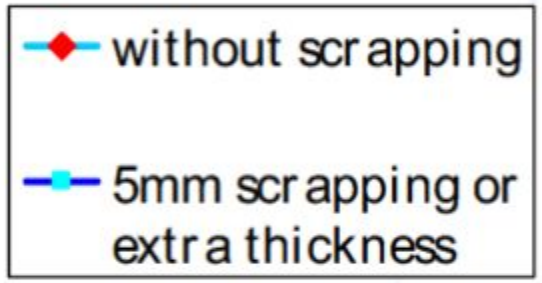
improvement of the mechanical properties

800°C		CLC0520	CLC0521	CLC0522
PVD	%	-0,1	-0,26	-0,19
MOR	Mpa	10,3	8,0	7,7
COMP	Mpa	56,7	63,9	67,4
MVA	g/cm3	2,24	2,01	2,02
PO	%	20,4	27,7	26,5
ABRASION (Calculation with SQF calculator)	cm3	**9,8**	**10,3**	**10,2**
ABRASION (Test ASTM) done physically (NW)	cm3	**8,88**	**8,36**	**8,22**

solution, benefit



positive effect of one layer solution to minimize the rebound.



03 materials available

material available

CALDE® GUN F 32 A

fireclay based
density = 1,88 g/cm³ (800 °C)
thermal conductivity = 0,81 W/mK (800°C)
CCS = 20 Mpa (800°C)

CALDE® GUN R 50 A

acid fireclay based
density = 1,83 g/cm³ (800°C)
thermal conductivity = 0,76 w/mK (800°C)
CCS = 45 Mpa (800°C)

CALDE® GUN CLC 0524 (lab no.)

fireclay based
density = 1,97 g/cm³ (800°C)
thermal conductivity = 0,95 W/mk (800°C)
CCS = 67,4 Mpa (800°C)

Thank you for your attention

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