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PARAMETERS INFLUENCING WET TENSILE STRENGTH OF MOULDING MIXTURE

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Abstract: *Scabbing occurs when pouring large size castings, resulting in presence of scabs in castings. Pouring of molten metal exerts following influences on the mould: mechanical influences, chemical and heat influences. Heat introduction dries the mould, so that at the top of the mould cavity we have temperature approximately equal to temperature of the molten metal, which varies depending on the height of the mould. Water content in the mould evaporates and condensate in the mould zone called wet tensile zone, where temperature reaches 100ºC. Consequently we get reduction of mould mixture strength, scabbing, falling and creation of sand scabs on the casting.*

Numerous variables affect this phenomenon of scabbing, whereby our paper undertakes to examine only a few of them, such as: moisture percentage, bentonit content, medium size of quartz sand and mould compression strength.

Key words: *scabbing in the mould, influential parameters, wet tensile strength*

1. INTRODUCTION

From the very beginning castings have found wide spread use in segments of machine building industry. Histogram representation given in figure 1.1 (Engles,1989.) shows share of castings in particular branches of machine building industry, while figure 1.2 shows part of casting production assortment.(Bonacic & Budic, 2001.)
Figure 1.1 shows high level of participation of castings in many branches of machine building industry.
The production assortment displays extensive application of castings.

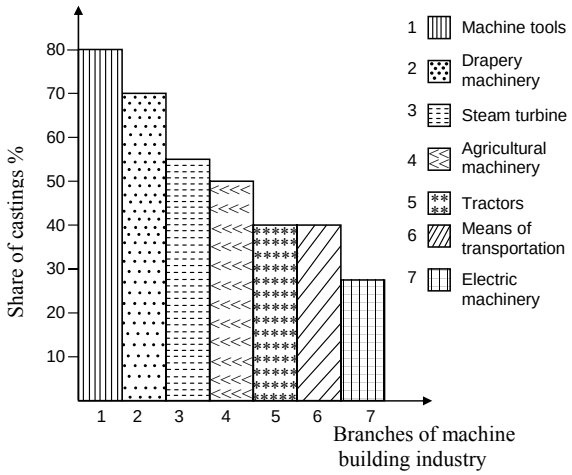

Fig. 1.1 Share of castings in single branches of machine building industry

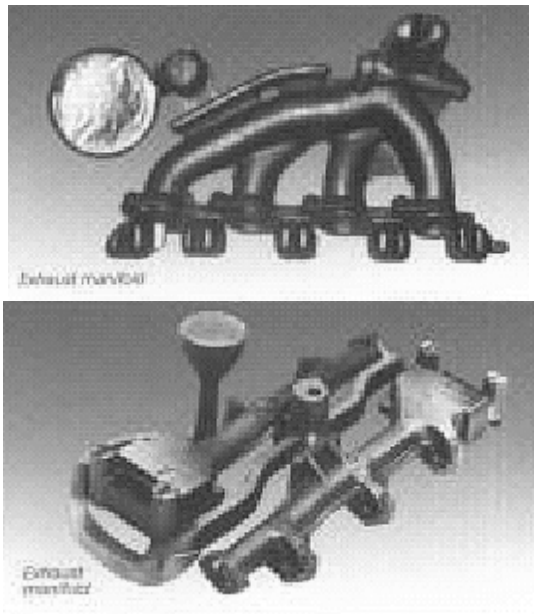

Fig 1.2 Part of casting production assortment

In the middle of 20th century requirements come up over and over again for unified and standardized casting quality, for high dimensional precision, smooth surface; simultaneously setting very strict demands regarding operating and environmental conditions. While scabbing of mould mixture results in surface defects on the castings, newly raised quality requirements lead to increased need to investigate the phenomenon of mould scabbing.

2. EARLIER RESEARCH OF SCABBING PHENOMENON

Pouring of molten metal leads to drying of the mould cavities (figure 2.1) (Bonacic & Budic, 2001)

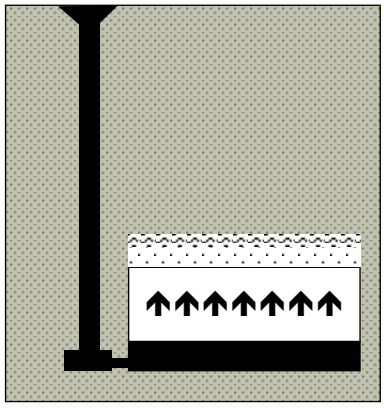

Fig. 2.1 Mould appearance

On the top of the mould cavity temperature equals the temperature of the molten metal (T_{melt}) which changes depending on the height of the mould. At the certain height of the mould cavity ($\approx$10 mm) mould temperature amounts to circa 100^0 C, retaining constant value along the height of the mould. Temperature distribution is shown in figure 2.2 (Bonacic & Budic, 2001.)

Heat affects the surface of the mould cavity, which is being dried, due to the evaporated water, which condenses in the mould zone called wet tensile zone, having 100^0 C temperatures. Moisture content on the contact surface between molten metal and the mould is zero, because water evaporated to colder mould zones, condensed again and reached its maximum ($H_2O_{\text{wet tensile layer}}$) figure 2.3 (Bonacic & Budic, 2001.) .

Moisture above wet tensile zone along the height of the mould is constant. Due to increased water content we get change in mould strength figure2.4 (Bonacic & Budic, 2001.).

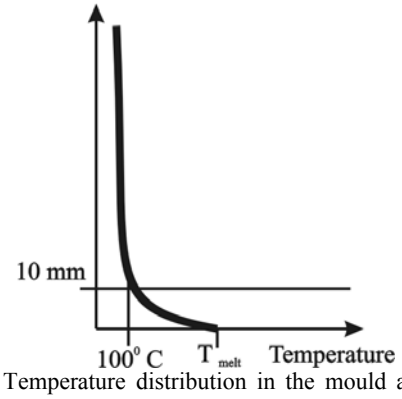

Fig. 2.2 Temperature distribution in the mould above the mould cavity

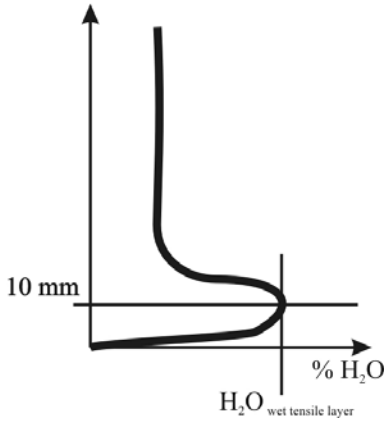

Fig. 2.3 Change of moisture in the mould above the cavity

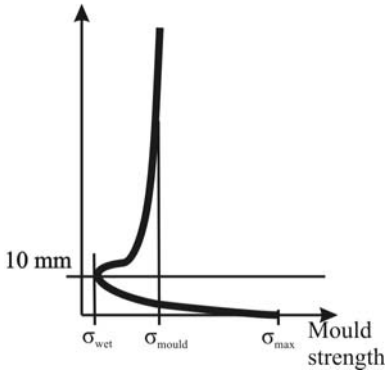

Fig. 2.4 Change of mould strength above the mould cavity

Regarding mould strength it is maximal σ_{max} at the contact surface between mould and the molten metal, minimal in the wet tensile zone σ_{wet} being constant along the height of the mould σ_{mould}.

3. RESEARCH OF WET TENSILE STRENGTH

Research was conducted on probe sample ø50 x 50 mm under application of the following influential parameters:

- Moisture content in the mould mixture
- Number of strokes (compression of the mould mixture)
- Sand granulation (medium size grain SV)
- Quantity of bond (bentonite)

The mould mixture was made by mixing (10 minutes) of sand, bond, additives (coal dust) and water in laboratory mixing device (figure 3.1)

Wet tensile strength was measured by apparatus + GF + type PZN according to figure 3.2

Fig. 3.1 Laboratory mixing device

Fig. 3.2 Apparatus for measuring of wet tensile strength+ GF + type PZN

Basic mould mixture features:

Sand:
- Manufacturer: Kvarc Asvany, Hungary, type KH-20.2,
- Chemical properties: SiO_2 (min) 98%,
- CaO (max) 0,2 %
- Other oxides (max) 1,4%
- Sintering point (sticking) 1450 ^{0}C,
- Medium grain size 0,205 mm

Bond (Bentonit):
- Type: Bentonplast: 30
- Manufacturer: Petrokemija d.d., Proizvodnja glina Kutina, R. Croatia
- Moisture 7,2 %
- Granulation < 0,063 mm
- Swelling 54 ml

Mineral blackness
Type: Inakol S
- Manufacturer: Petrokemija d.d. Proizvodnja glina Kutina, R. Croatia
- Annealing loss 40,2 %
- Glitzy carbon 7,2 %
- Volatile substance 24,8%
- Content in mixture 4%

3.1 Testing of moisture influence

Mould mixture featured:
- Sand SV 0,205
- Bond 5%
- Number of hammer strokes: 3
- Moisture 3 … 6 %

3.2 Testing of influence of number of strokes (compression)

Mould mixture featured:
- Sand SV 0,205
- Bond 5%
- Moisture 3 %
- Number of hammer strokes 3 … 9

3.3 Testing of influence of sand granulation

Mould mixture featured:
- Bond 5 %
- Moisture 3 %
- Number of hammer strokes 3
- Sand SV 0,18 … 1, 95

3.4 Testing of bond content

Mould mixture featured:
- Moisture 3 %
- Number of hammer strokes 3
- Sand SV 0,205
- Bond 5 … 15 %

4. RESULTS OF TESTING OF WET TENSILE STRENGTH

Research results are showed in (Table 4.1 ….. 4.4).

4.1 Influence of moisture

Moisture (%)	Wet tensile strength (N/cm^2)
3,0	0,23
3,3	0,30
3,6	0,32
3,8	0,33
4,0	0,34
4,5	0,34
4,9	0,31
5,2	0,30
5,9	0,25

Table 4.1 Influence of moisture on wet tensile strength

4.2 Influence of number of hammer strokes (compression)

Number of strokes	Wet tensile strength (N/cm^2)
2	0,26
3	0,28
4	0,35
5	0,37
6	0,38
7	0,39
8	0,36
9	0,32

Table 4.2 Influence of number of strokes on wet tensile strength

4.3 Influence of sand granulation

Sand granulation (mm)	Wet tensile strength (N/cm^2)
0,18	0,10
0,205	0,12
0,259	0,16
0,309	0,21
0,42	0,28
0,61	0,35
1,28	0,35
~1,95	0,35

Table 4.3 Influence of sand granulation on wet tensile strength

4.4 Influence of bond content (Bentonit)

Bond content (%)	Wet tensile strength (N/cm^2)
3	0,19
5	0,28
7	0,31
10	0,38
12	0,32
15	0,24

Table 4.4 Influence of bond content on wet tensile strength

5. RESULT EVALUATION

Measurement results of wet tensile strength from Table 4.1 … 4.4 are shown in diagrams in Fig. 5.1 … 5.4.

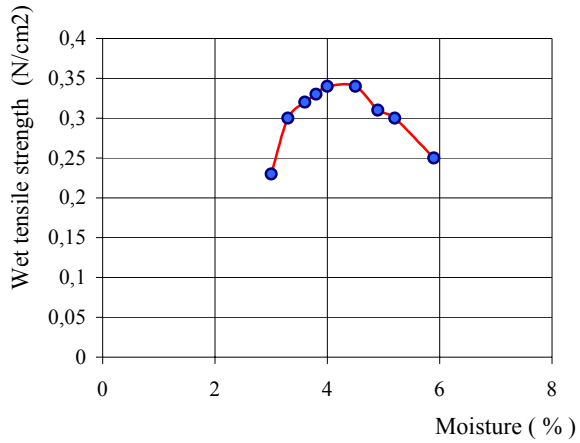

Figure 5.1 Dependence of wet tensile strength on moisture content

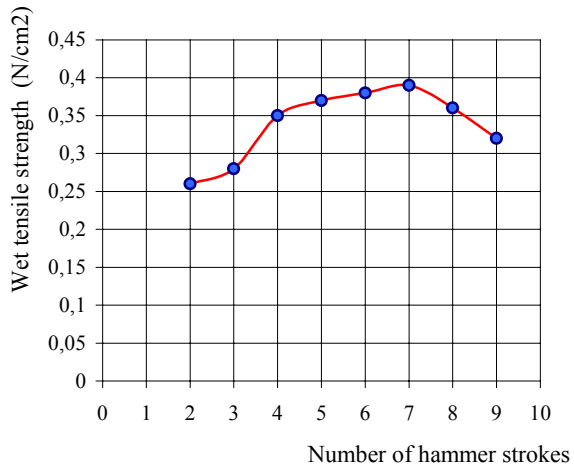

Fig. 5.2 Dependence of wet tensile strength on number of hammer strokes

5.1 Moisture content

It can be seen from Fig. 5.1 that wet tensile strength grows up to – 4, 5 % of moisture content, and after that it decreases. Increase of moisture content leads to porosity reduction, so that moisture cannot pass to deeper layers, creating zone of great moisture content, which results in decline of re-condensation strength.

5.2 Influence of number of hammer strokes (compression)

With increase of number of hammer strokes (up to 6) we obtain growth of re-condensation strength. Lesser number of numbers of strokes relocates sand particles increasing density of mould mixture. This leads to decline of porosity. Due to small porosity, vapour cannot reach deeper mould layers, resulting in moisture content increase in re-condensation zone and consequently to decline of re-condensation strength.

5.3 Influence of sand granulation

In diagram it can be seen that wet tensile strength grows up to SV = 0,6mm, retaining after that constant values. Mixing device chops sand particles so there is no need for application of coarse sand particles.

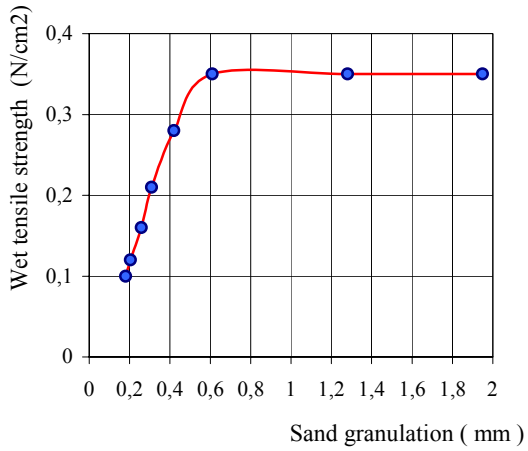

Fig. 5.3 Dependence of wet tensile strength on sand granulation

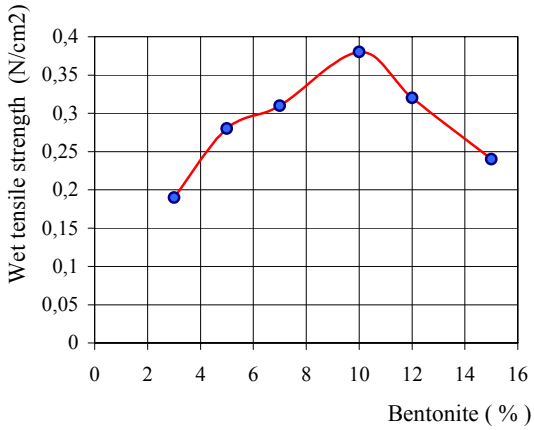

Fig. 5.4 Dependence of wet tensile strength on bond

5.4 Influence of bond content (Bentonit)

Wet tensile strength is up to 10 % of bond content, declining after that with increase of bond content. Namely content bond content increase over 10% there remains not enough moisture for activation of bond, increasing share of smaller fractions and decline of wet tensile strength.

6. CONCLUSION

This paper studies the influence of moisture, mould mixture compression, sand granulation and bond content in the mould mixture on wet tensile strength. Results are singled out in Chapter 5.
Further research follows by inclusion of more influential parameters, so as to reach more precise results.

7. REFERENCES

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