# «DISA Match ile Fren Kampanası Üretimi»

## «DISA Match Truck Brake Drum Production»

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**2.Oturum: Döküm Teknolojileri Demir-Çelik**

**2nd Session: Casting Technologies Iron&Steel**

***Oturum Başkanı/Session Chairman: Gürolhan Yaşar (Demisaş Döküm Emaye Mam. San. A.Ş.)***



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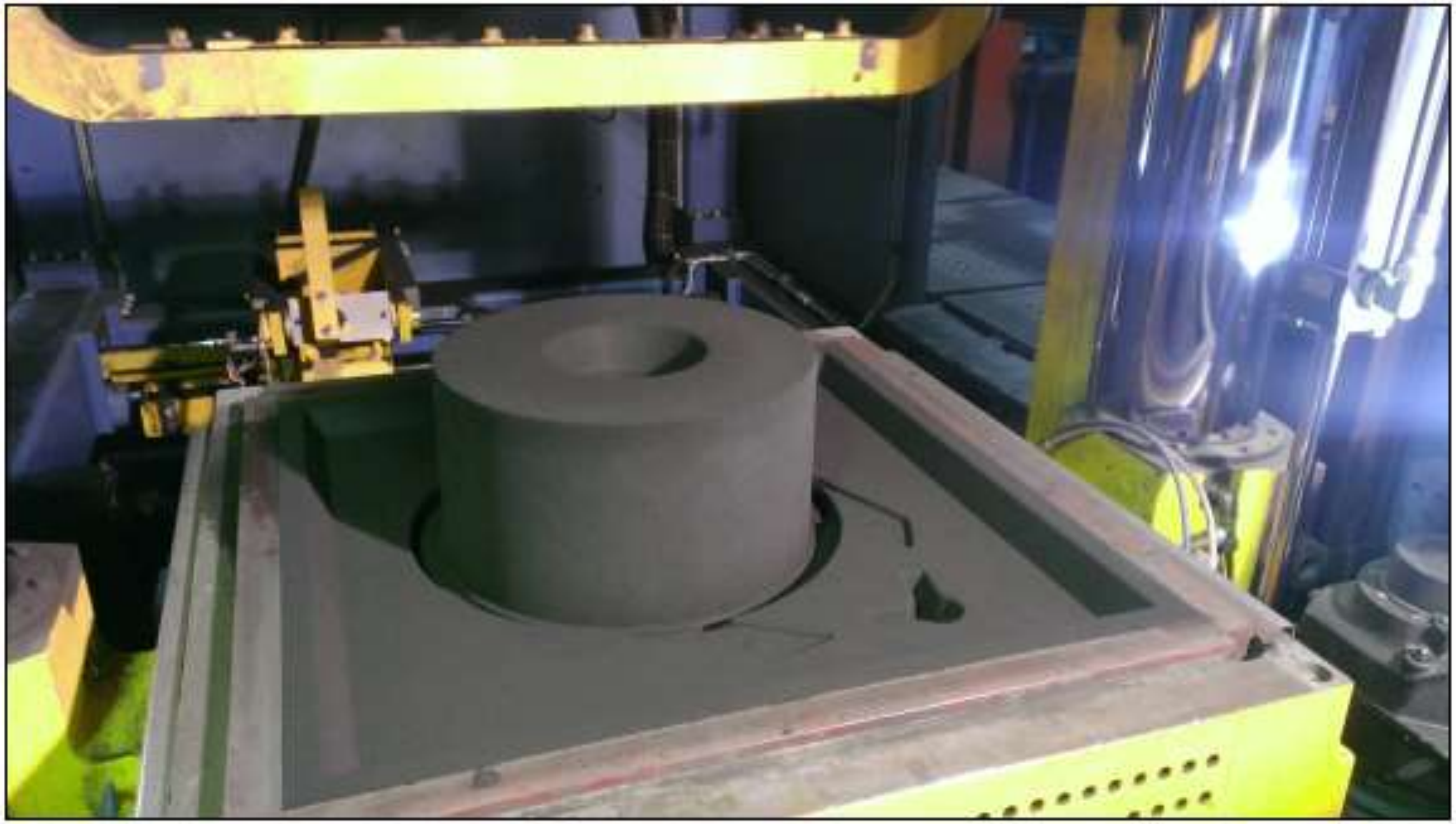
# DISA MATCH
# Truck brake brum production

Presented by: Steven Rømer,

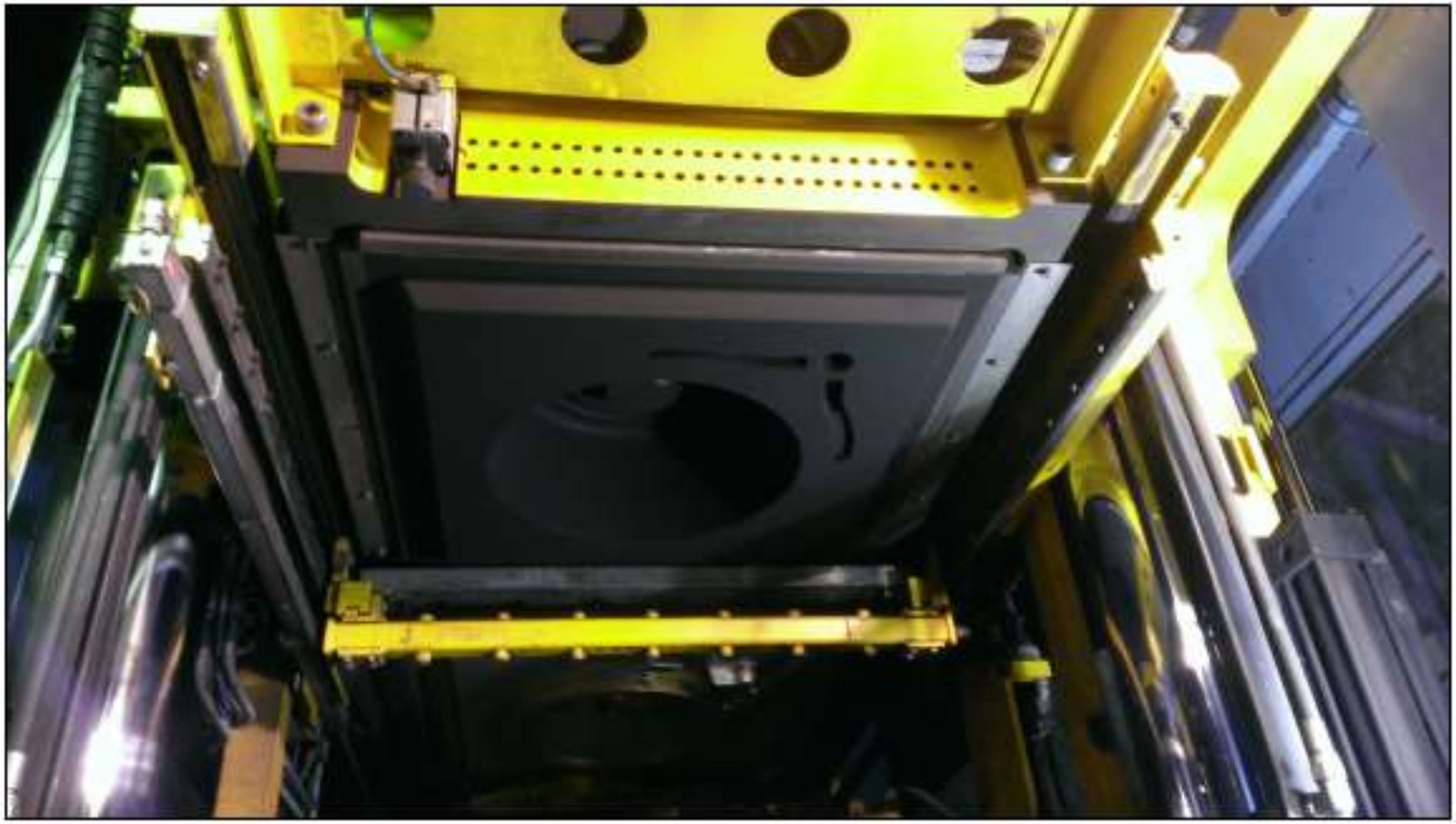
Manager Foundry Optimization, DISA Industries

# Case story – Brazil



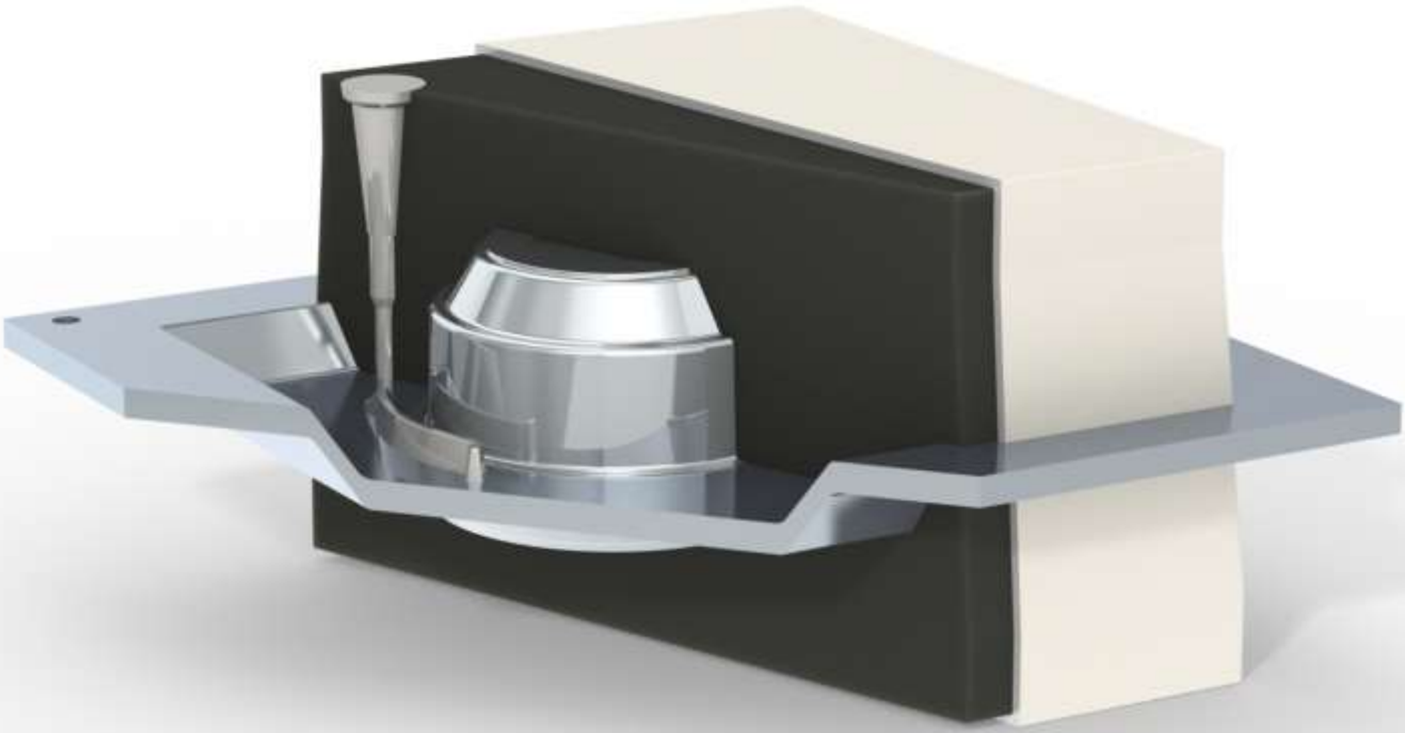
DRAG Mould impression

# Case story – Brazil

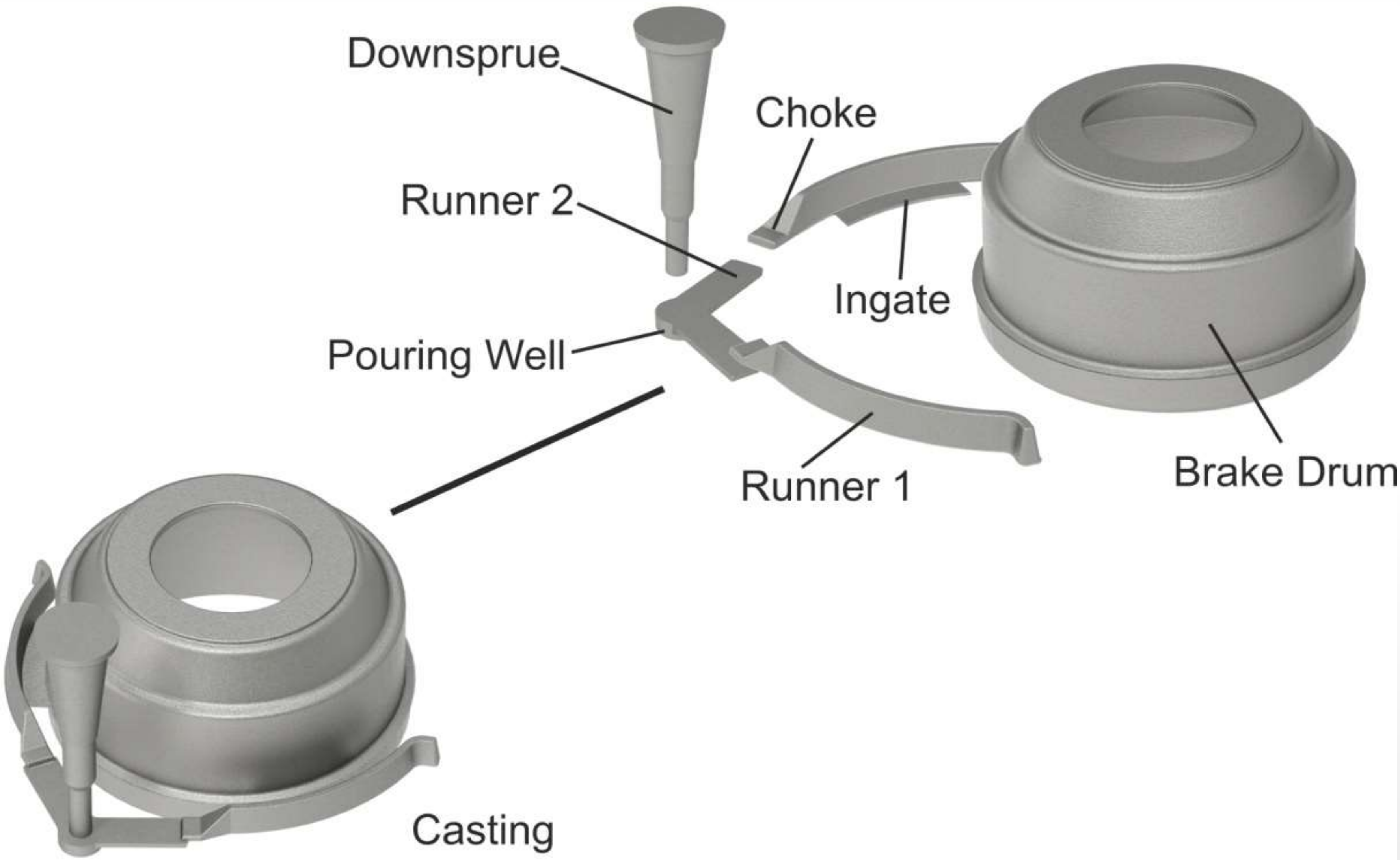


COPE Mould impression

# Brake Drum for Match Plate – Gating Calculation



# Overview of gating system



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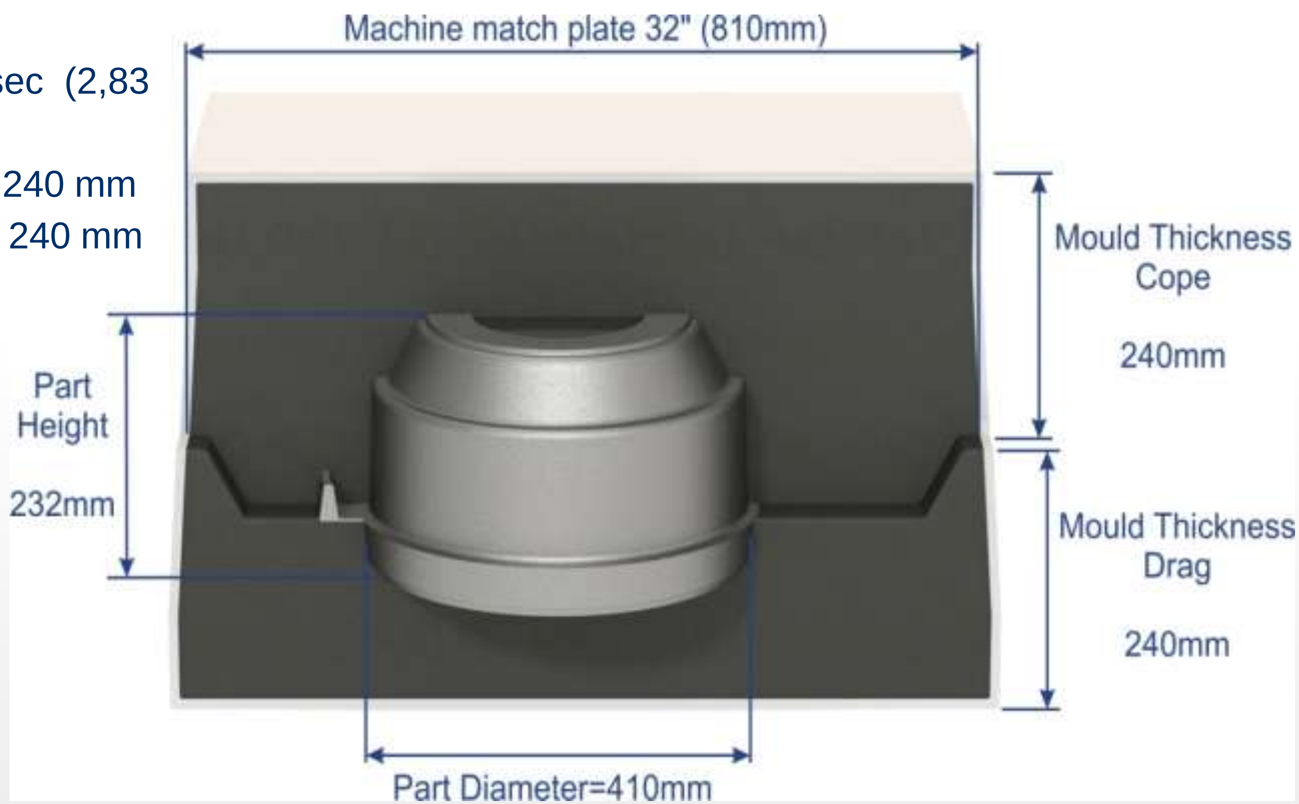
# Data

- Part weight: 34 kg (casting)
- Material: Grey Iron
- Machine: DISA MATCH 32 x 32
- Part diameter: 410 mm
- Part height: 232 mm
- Part pouring time: 12 sec  (2,83 kg/sec)
- Mould thickness drag: 240 mm
- Mould thickness cope: 240 mm



# Layout

The chosen machine is a match plate 32 x 32 and mould thickness for drag and cope is initially 2*240 mm.

Sand/metal ratio should preferably exceed 5, which will be checked when the gating system has been calculated.

Casting pouring rate is $\frac{34\ \text{kg}}{12\ \text{sec}} = 2{,}83$ kg/sec

To avoid breakage on the surface or on the inside of the mould, the previously described pattern layout formulas has been applied

$$M_s = Solidification\ Modulus, mm.$$
$$H_t = H_3 + H_4 = Total\ Pattern\ Height, mm$$
$$H_m = a - \left(\frac{b}{2}\right) = Metallostatic\ Height$$

$$a = M_s \cdot 1{,}5 + H_t \cdot 0{,}25 + K_1, mm$$
$$b = M_s \cdot 1{,}5 + H_t \cdot 0{,}25 + K_2, mm$$
$$c = M_s \cdot 1{,}5 + H_t \cdot 0{,}25 + 25, mm$$

# Layout

Where Ms is the solidification modulus in mm, which has been estimated to 10 mm and K1 and K2 are mould-size dependent values from

| DISA MATCH | 130 | 24"x 28" | 28"x 32" | 32"x 32" |
|---|---|---|---|---|
| **K1** | 20 | 28 | 37 | 43 |
| **K2** | 30 | 42 | 56 | 63 |

$$Solidification\ Modulus\ M_s = 10mmH_t$$
$$= 116mm + 116mm = 232mma$$
$$= (10 \cdot 1{,}5) + (232 \cdot 0{,}25) + 43 = 116mmb$$
$$= (10 \cdot 1{,}5) + (232 \cdot 0{,}25) + 63 = 136mm$$

# Calculation of dimensions of ingates, runners and chokes

## Metallostatic Height

The metallostatic height is: Hm= a – (b/2) = 306 – (182/2)= 215 mm


Dimensions a and b determining the metallostatic height



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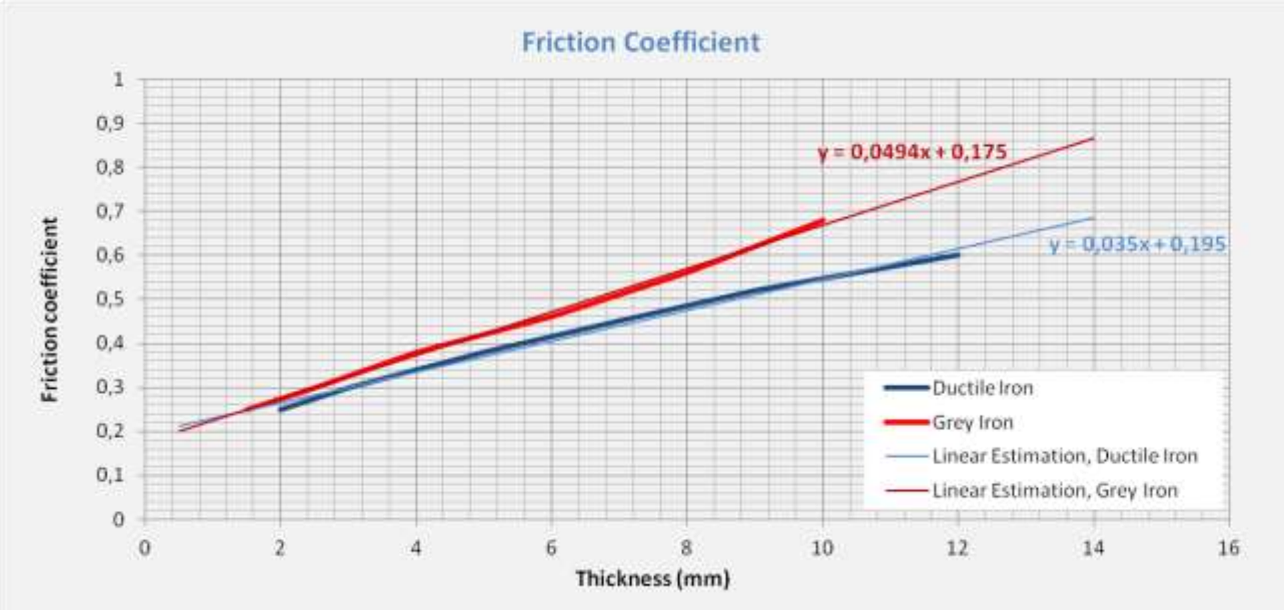
# Ingate, section G1

Generally (for iron), it can be shown that: $$A = \frac{1036 \cdot G}{t \cdot m \cdot \sqrt{H_m}}$$

where *A* is the area of the given cross-section (mm$^2$), *G* is the total mass (kg) through the area, *t* is the pouring time for filling the rest of the cavity, *m* is friction coefficient while *H* is the metallostatic height (mm).

The friction coefficient *m* can be read from figure 4.2.1.



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# Ingate cross-section area

An ingate thickness of 2,5mm is decided and from figure 4.2.1 we get a friction coefficient of $m$=0,299 when using grey iron.

With an ingate thickness of 2,5mm, we need a cross-sectional area of the ingates to be:

$$A_{ingate} = \frac{1036 \cdot 34}{0,299 \cdot 12 \cdot \sqrt{215}} = 668,55\ \text{mm}^2$$

With a thickness of 2,5mm, the ingates should thus have a total width of:

$$\frac{668,55}{2,5} = 267,4mm.$$

Two ingates with a total width of approximately 270*mm* can be obtained with a width of each of the ingates of 135*mm*.

The length of the ingates is decided to be 25 mm, hence the weight is:

$$W_{\text{ingate}} = (2,5 * 135) * 25\ \text{mm}^3 * 7200\ \text{kg/m}^3 * 10^{(-3*3)} = 0,061\ \text{kg}$$



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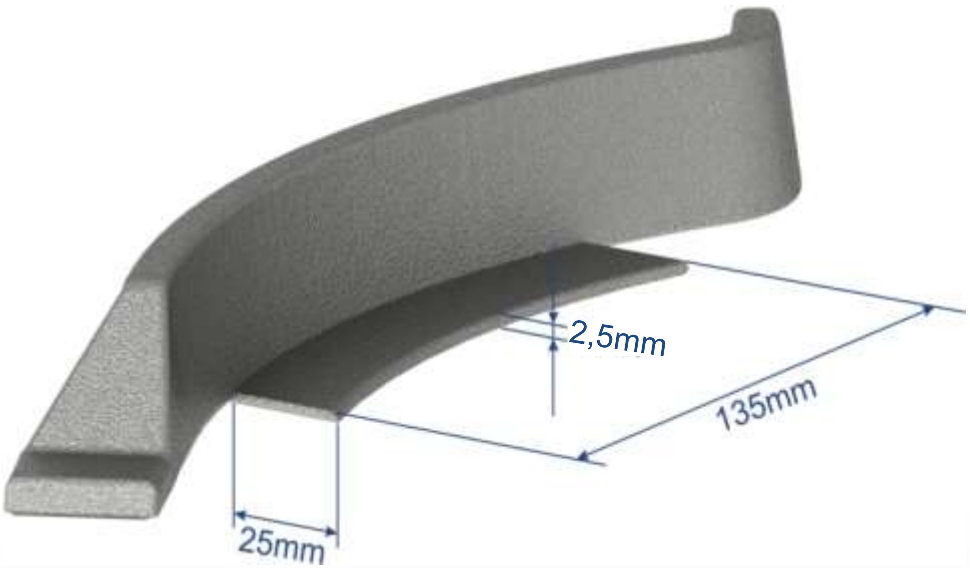
# Ingate cross-section area




*Dimensions of ingates. Length is selected by choice, thickness and width is dimensioned by necessity based on pouring time.*

# Ingate Reynolds number

The Reynolds number for the ingates are: $\frac{W \cdot 10^5}{T \cdot p}$, where W is the weight [kg], T is the filling time [sec] and p is the perimeter length [cm] of the cross-section.

With 2 ingates the calculation is:

$$Re_{Ingate} \frac{\left(\frac{34}{2}\right) \cdot 10^5}{12 \cdot 27{,}5} = 5151$$

The perimeter is (2*0,25 + 2*13,5) = 27,5 cm (275 mm) and a Reynolds number of up to approximately 4800 is normally considered to ensure laminar flow, so this cross-section should not lead to flow conditions that are too turbulent, even if the Reynolds number is slightly higher.

# Runners

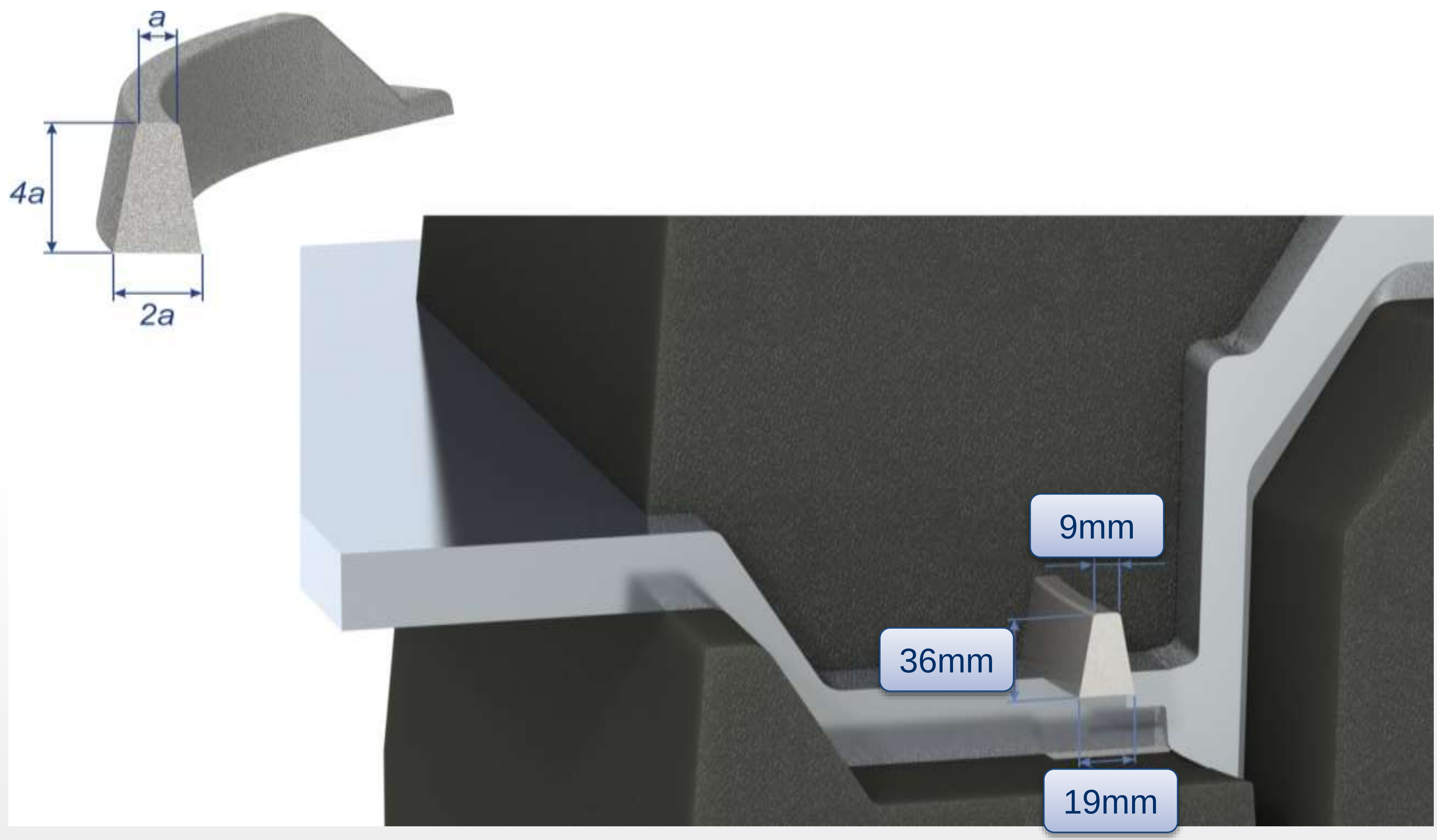
The runners are, based on experience, made 50% larger than the ingates G1:

$$A_{Runner1} = 1{,}5 * A_{ingate} = 1{,}5 * (2{,}5*135)\ \text{mm}^2 = 506{,}25\ \text{mm}^2$$

A slender runner (trapezoid with distance *a* in the top, 2*a* in the bottom and 4*a* in the height, see figure 4.3.1) is used for the cross-section:

$$A_{Runner1} = 6a^2 \leftrightarrow a = \sqrt{\frac{A_{Runner1}}{6}} = \sqrt{\frac{506{,}25}{6}} = 9{,}18\ \text{mm}.$$

# Runners




*Dimensions of runner 1*

# Runners

This results in a trapezoid where the height is 36 and the top and bottom side lengths are 9 and 19 mm. The area becomes (9+19)/2 * 36 $mm^2$ = 504 $mm^2$. For the weight-calculation, the length of the runner is chosen to be 280 mm. The weight becomes:

$$W_{Runner1} = 504 * 280 * mm^3 * 7200\ kg/m^3 * 10^{(-3*3)} = 1{,}016\ kg$$

With the initially calculated pouring time of 2,83 kg/sec, the filling time of a runner is:

Filling time, Runner1= (1,016 kg/ 2,83kg/sec) = 0,18 sec.

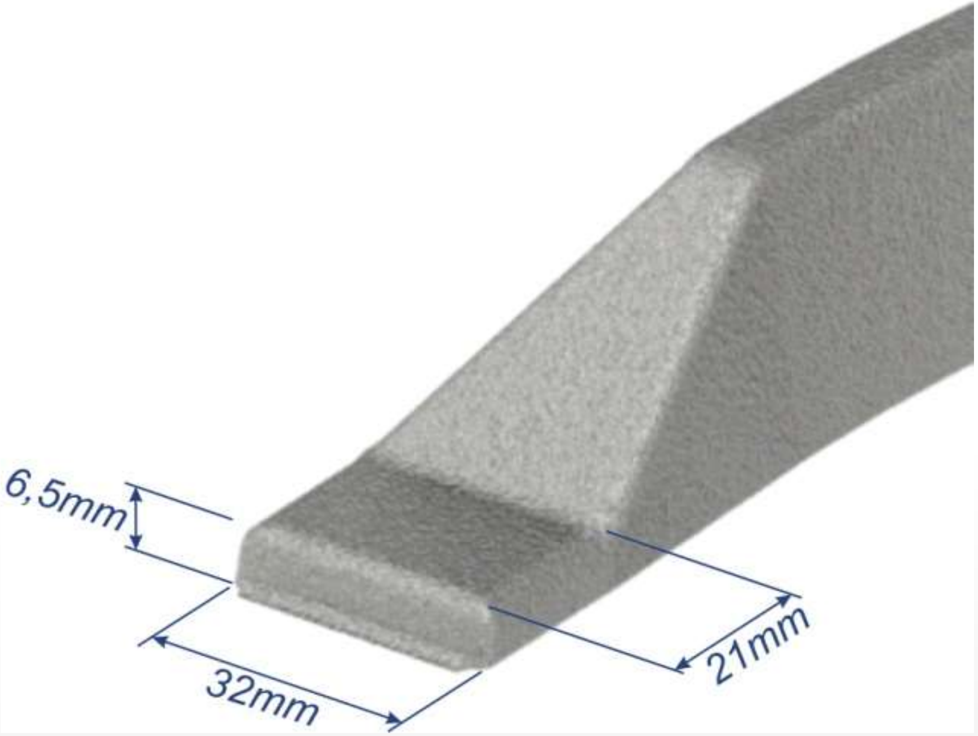
# Choke

The choke area is again calculated using the metallostatic pressure height and a thickness of the choke of 6,5mm is decided. This gives a corresponding to a friction factor coefficient of 0,496 for grey iron, according to the graph in previous slide

$$A_{Choke} = \frac{1036 \cdot (\frac{34}{2} + 0,061 + 1,016)}{0,496 \cdot (12 + 0,18) \cdot \sqrt{215}} = 211,41 \text{ mm}^2$$

The total casting weight has been divided by 2 ingates and the previous two results for $In_{1,weight}$ and $R_{1,weight}$ has been inserted because metal to these parts must pass through the area $Chk_1$. The area $Chk_1$ has been decided to be 6,5*32 = 208 ≈ 211,41 mm$^2$.

# Choke




*Dimensions of choke*



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# Runner

Runner R2 is made similarly to R1: 50% larger than the restricting area, $Chk_1$:

$A_{Runner2}$ = 1,5 * $A_{Choke}$ = 1,5 * 208 = 312 $mm^2$.

A thickness larger than the thickness of the choke (6,5mm) is required and a thickness of 8mm and a length of 92mm is decided.

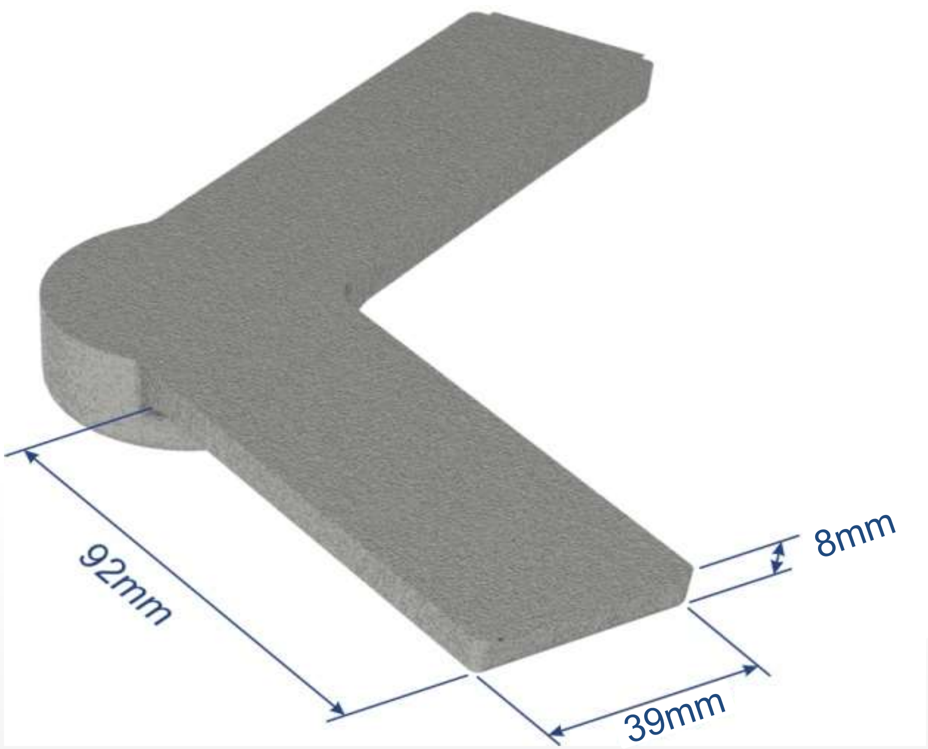
With a thickness of 8mm and a required cross-section area of 312 $mm^2$, a width of:

$$Width_{Runner2} = \frac{312}{8} = 39mm$$

This gives a weight of Runner2 of:

$W_{Runner2}$ = 312 * 92 * $mm^3$ * 7200 $kg/m^3$ * $10^{(-3*3)}$ = 0,207 kg

# Runner




*Dimensions of Runner2*

# Yield and sand/metal ratio

## The yield calculation becomes:

| Part weight | 1 * 34 kg | 34 kg |
|---|---|---|
| Ingate G1 weight | 2 * 0,061 kg | 0,122 kg |
| R1 weight | 2 * 1,016 kg | 2,032 kg |
| R2 weight | 2 * 0,207 kg | 0,414 kg |
| Well weight | 1 * 0,282 kg | 0,282 kg |
| Downsprue weight | 1 * 3,895 kg | 3,895 kg |

Total iron weight is 40,745 kg and the yield is 34/40,745 kg = 83,4 %.

Sand/metal ratio can be calculated by assuming drag and cope mould thickness to be 240 mm while in this example the mould size is 810 x 810.

Sand weight: $(2 * 240) * 810^2\ mm^3 * 10^{(-3*3)}\ m^3/mm^3 * 1500\ kg/m^3 = 472,4\ kg$

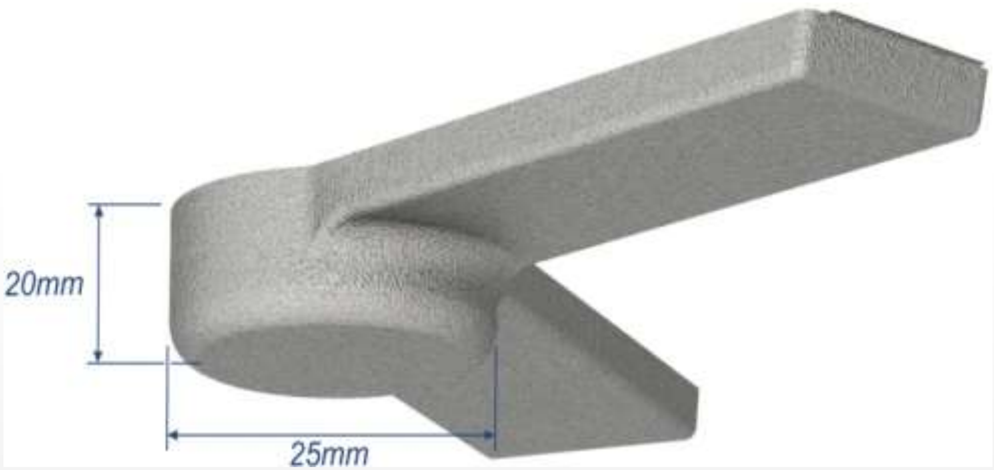
With total iron weight of 40,745 kg, the sand/metal ratio is 11,6. Alternatively, one can subtract the volume of the iron from the sand and calculate a more accurate sand/metal ratio. This is relatively easy because the mass and density of the iron is known. The difference in sand/metal ratio however is very small of two reasons: First, the density of iron is approximately 5 times larger than that of the sand and additionally a second reason is that there’s typically much more sand than iron in the mould.

# Recommendations

## Pouring Well

It is recommended to fit the mould with a pouring well below the downsprue.

The downsprue should be selected according to estimated pouring time and mass flow and a pouring well of at least same diameter as the lower part of the downsprue, and preferably larger, should be prepared.



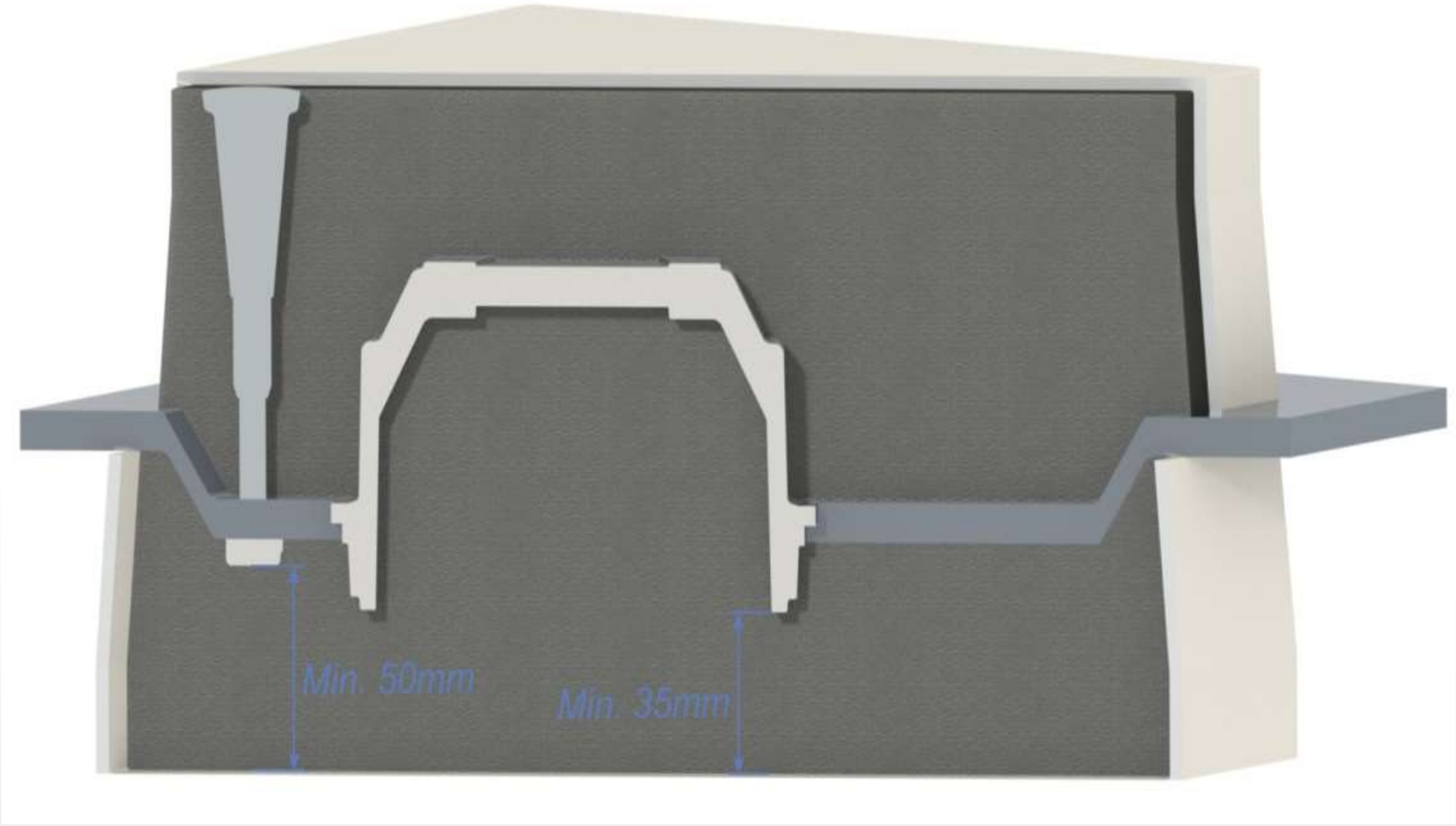

*Dimensions of pouring well*

# Recommandations

## Minimum sand thickness at edges

DISA generally recommends a minimum sand thickness towards mould chamber confinement of between 35mm-50mm, depending on mass flow and speed.

Especially under the pouring well, the sand thickness is important to minimize the risk of run-through and a minimum thickness of at least 50mm is recommended. The sand thickness under the part itself, where flow is slower (particular in vertical direction) the sand thickness can be reduced to approximately 35mm, if necessary.




*Sand thickness recommendations*

# Result


Brake drum castings

# Thank you for your attention