

RECOMMENDATIONS FOR THE MANUFACTURE OF POLYSTYRENE MODELS FOR THE LOST FOAM PROCESS

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1. Polystyrene Material

It is necessary to mention that the base to obtain quality castings with the lost foam process is conditioned by the quality of the pattern itself. In this way, Fundiciones Fumbarri deems it fundamental to improve the exchange of knowledge and relationship between: Designers, Patterns Makers, Testers and Smelters. To this end, Fumbarri wants to provide its experience, which with this series of recommendations, contribute to improving the quality of the castings.



The most important aspects of the polystyrene material that is used for patterns manufacturing are presented below:

1.1. Polystyrene's Density

It is FUNDAMENTAL that the polystyrene's density be as normally used in patterns manufacturing, that is, approx. 20 Kg/m³. It is essential because the amount of iron to be poured into the mould is calculated on the basis of ratio between the polystyrene and iron density.

- a) If the density is less than standard, the casting is carried out with less iron, with the risk that the mould is not filled, losing both the pattern and the casting.
- b) If the density is greater, the casting will be carried out with an excessive amount of iron, and there may be several tonnes of excess in the ladle, with nowhere to pour it.

Additionally, low-density polystyrene is easily ruined and broken, with inferior surface quality after machining, which is transmitted to the casting.

1.2. Polystyrene's Drying Status

Regarding polystyrene drying status is important to know that if the polystyrene is too fresh when the pattern is made, it loses its moisture, and a contraction occurs when the pattern is finished. This contraction will be added to the iron's solidification. Therefore, for large grade elevations, plane differences may be problematic. In order to confirm this fact, a study was performed on polystyrene contraction. The drying process in the furnaces was monitored, both gross plates (factory origin) and patterns built with polystyrene. This study verified that the plates decreased by up 0.30%, according to the freshness of the material, and the polystyrene patterns contracted at a magnitude of 0.20%.

To avoid possible problems with the casting, where repair is costly or impossible, it is highly recommended taking the quality of the polystyrene into account IN TWO ASPECTS:

1. In order to be able to use polystyrene plates, they must be completely contracted. That is, enough time should pass from their manufacture to their use in patterns, so their dimensions are not affected later on.
2. The density of the polystyrene that is cured in this fashion, should be approx. 20 Kg/m³ to prevent false calculations.

1.3. Polystyrene's Quality

To obtain a good surface finish for the castings, it is fundamental that the polystyrene's quality is good and for the surface finish to be thin. In this regard, it is recommended:

- The polystyrene plates must be manufactured with pearls (balls) with small diameters (Ø1.5 to Ø2.5 mm).
- Polystyrene machining conditions must be adequate, such that the polystyrene is not ripped or burned from friction.



- Using a cutting tool that is in good shape and quality is crucial to obtain thin surface finishes. It is recommended to use a specific tool for polystyrene machining.
- The surface quality of casting is conditioning by the thinness of the pattern. If the pattern's finish is thin, a thin casting surface shall be obtained.



2. Pasting and Wrapping

2.1. Pasting

Proper pasting for sheets and layers is fundamental to ensure sufficient rigidity, ensuring that the model is not broken in handling. The pasting process must be performed minutely on parallel sides, ensuring that the paste covers the entire joint surface, and that the joints are not forced upon pasting. We recommend paying special attention when crossing the plates so that their joining does not take place on one sole plane, which would weaken the model and would make it easier to break them in painting, drying and other handling processes for the casting model.



2.1. Wrapping

Wrapping acts to cover the joints between the model's plates or layers. Covering the joints acts to prevent refractory paint and/or sand from penetrating inside the castings.



Wrapping must be carried out on the model's interior and exterior joints. This is because this is the only way to prevent the joints or castings from separating. We recommend using adhesive tape, that sticks well, that withstands humidity and that is elastic.



3. Labelling

Proper legibility of relief labels influences the type, size and positioning of the labels. In this regard, we make the following recommendations:

- a) Type: Letters, numbers and logotypes should not be hollow or should be thick enough to withstand firing the models.



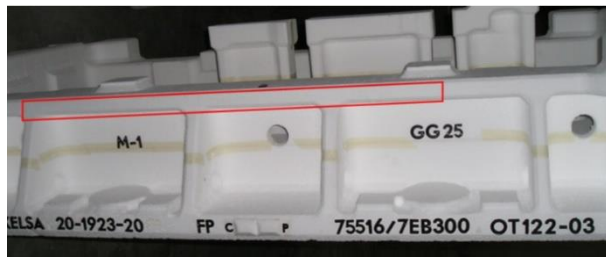
Defects originating from using hollow letters.

- b) Size: We propose that the labels be as large as the model allows.

- c) Relief: The vertices of the labels must be marked and extend 5 mm at minimum.



- d) Position: It is advisable that the references be located in areas where the mould-metal reaction is affected as slightly as possible; in other words, as close as possible to the work side.

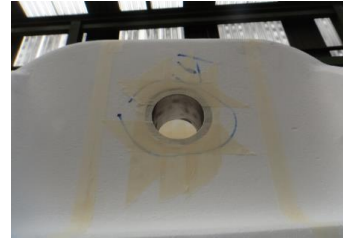


FUMBARRI ADVISES THAT THE REFERENCES BET PLACED IN THE AREA FRAMED IN RED IN THE PHOTOGRAPH

4. Metallic Inserts

4.1. Metallic Tubes in Holes for Transport Pins

In all cases, we recommend that the transport pin tubes arrive straight from the modeller assembled, pasted and wrapped. In this fashion, it is ensured that the tubes are properly adjusted without any space where the refractory paint could penetrate, creating discontinuities between the tube and the casting.

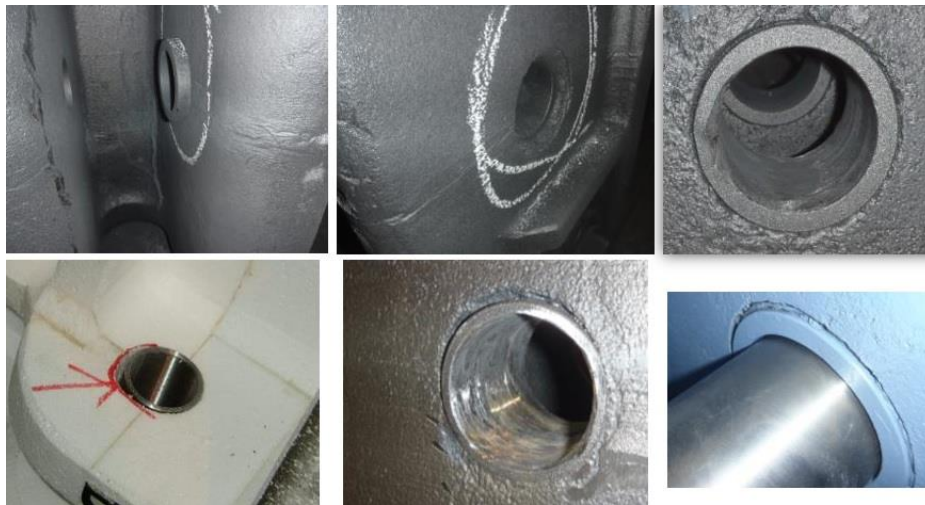


The delivery note for the models should indicate the weight of the inserts for each brand.

A consequence of delivering the tubes without assembly, pasting and wrapping is normally that the tubes are loose in the polystyrene model, and during transport and storage of the models, these elements detach, leading to breakage in their different parts.



A normal result of delivering the tubes unassembled, not pasted and wrapped, is that the tubes are de-centred or displaced during the painting or moulding process, leading to them being displaced or de-centred in the part once cast.



4.2. Transport Eyebolt

The transport eyebolts should come from the modeller assembled, pasted and wrapped.

The area of the model withstanding the weight of the metallic elements should not be positioning in the model's layer pasting area. This keeps it from coming detached in the drying furnace, due to the weight.



The delivery note for the models should indicate the weight of the inserts for each brand.

4.3. Threaded Bushings

The threaded bushings should come separately to be able to handle the models with no risk for breakage and deformations. They should come in a box with the Client identification and Reference.



This work method, necessary to prevent breaking the models while handling them, has two inconveniences for casting when managing a high number of inserts. On one hand, there is a risk that the models will melt without having inserted any insert by mistake. On the other, there are traceability problems between the models and the inserts corresponding to each one.

In order to attempt to minimise these problems, the models and inserts must be received under the following premises:

- The housings where the insert must be inserted later on must have a diameter slightly smaller than the insert's so that it is under pressure during the moulding phase, after painting and drying the model.
- When painting the models, the interior of these housings cannot be painted, so they must come from the modeller prepared in the following fashion:

Each housing must be covered with a pressure polystyrene cover, so that this cover does not burst. For the cover (and thereby the housing) to be recognisable, it should extend at least 40 mm from the model's surface.

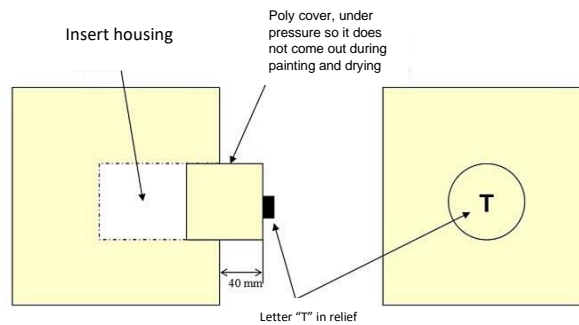
So that this cover is not confused with a model plane, it should be marked with a relief "T". It is not enough to paint the letter "T" with a marker, since it must be visible once the model is covered with the refractory paint.

This way, we can paint the model without paint entering the housing. Once the paint is dry, we remove the cover and the housing will be paint-free and ready to insert the insert.

The separated inserts for each model must be delivered in a separate box, identified with:

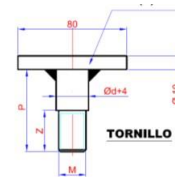
- Client Name, OT and brand for said model.
- The number of inserts it should contain.

The boxes containing the inserts must be resistant enough to withstand the weight and transport them.



SUMMARY OF ACTIONS TO APPLY:

1. To avoid looseness in assembling inserts, the housings must be at least 2 mm less than the exterior diameter of the bushing.
2. Each bushing housing should be covered with a pressure polystyrene cover that extends by 40 mm, with the T in relief, stuck to the cover.
3. The bushings must come with a screw according to blueprints, assembled on the bushing, and this screw must have loose threading and be lubricated with plenty of anti-heat grease to avoid gripping upon casting the part.



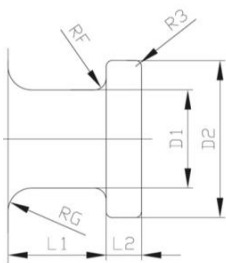
5. Elements for Attachment, Transport and Handling in Mechanisation

Process

A normal problem for elements that are eliminated after mechanisation, meaning that they only act for handling, transport or attachment of the die-cutter in the finishing phase. Regarding robustness, these elements are designed thinking solely of their end function in die-cutting or mechanisation, without taking the casting processes they undergo into account: removal from mould, blasting, deburring, handling, turning over and transport. They require greater resistance than planned in their design

5.1. Eyebolts

We recommend that appropriate measures for eyebolts so that they can withstand the entire casting production process with guarantees follow the following rule:



SIZE	D1	D2	L1	L2	RG	RF	Maximum Weight Transport with 2 Eyebolts
1	50	80	50	18	12	6	2. 100 Kg.
2	63	100	50	20	16	10	4. 200 Kg.
3	80	130	65	25	25	12	7. 600 Kg.
4	100	160	75	30	30	15	12. 700 Kg.
5	125	200	80	32	36	20	21. 200 Kg.
6	150	240	85	35	38	22	35. 400 Kg.

It is very important for the eyebolts joint to the model to be in a radius, since a square corner decreases resistance and increases fragility.



**YES
RADIUS**

**NO
SQUARE CORNER**

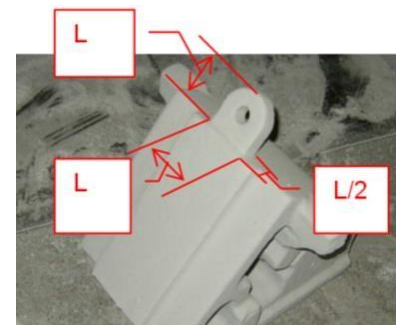
IMPORTANT: We must avoid placing previous eyebolts in areas that will be mechanised later on, since they create hot points, which leads to the appearance of pinhole porosity.



5.2. Rings

Rings will be used for parts less than 100Kg.

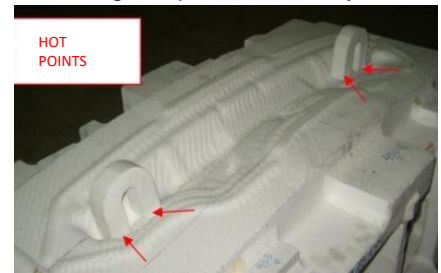
For rings, the part's joint surface must be such that the length that extends (L) = length of joint to part (L), with a joint width at half said length (L/2).



It is very important for the ring joint to the model to be in a radius, since a square corner decreases resistance and increases fragility.

On occasion, the rings are inappropriately placed on working sides, creating hot points that may lead to pinholes.

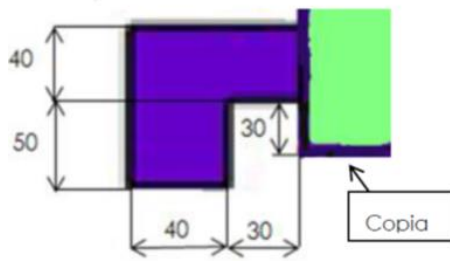
For this reason, we recommend, whenever possible, that these elements be located on non-functional surfaces that minimise the importance of the appearance of said pinholes.



5.3. Stands or legs for support

This type of element for mechanisation operations cannot excessively protrude from the part, since they are fragile in mould and burr removal operations, and may rip the part's material if suddenly detached. These legs will be preferably placed in non-mechanisable areas.

Recommended measurements for support legs attached in the males or rollers.



Under no circumstances must they excessively protrude, as their integrity is not guaranteed during the casting process, making safe handling of parts impossible.



**ERRONEOUS LEG CONCEPT
EXCESSIVE PROTRUSION**



5. Reinforcing Weak Elements

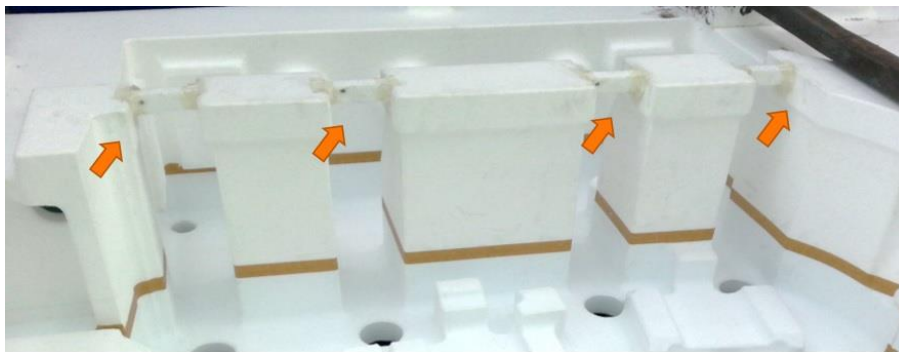
In order to ensure the integrity of models and parts once cast, the weak areas must be reinforced.

Any protruding element in the model must come from the modeller reinforced so that it does not break, either on the same model or on the part once cast. Weak zones located toward the corner, exterior or protrusions must also be reinforced. The braces must be thick enough for the element to be reinforced, using strips at minimum 20x20



5.1. Turrets

With the bases, it is important that modellers join the turrets (sites for: blades, wedges, matrices, reactions, etc.) together with braces, such that the turrets are not isolated. This acts to reinforce them, preventing them from deforming or breaking.



Joining the turrets ensures properly filling the part, preserving geometry without breakage or deformations.

The braces must be at minimum 20x20 and 40x40 maximum. This dimension shall be selected according to the size of the turret to be joined and the space available.

5.2. Press Base Anchoring Flange and Slots

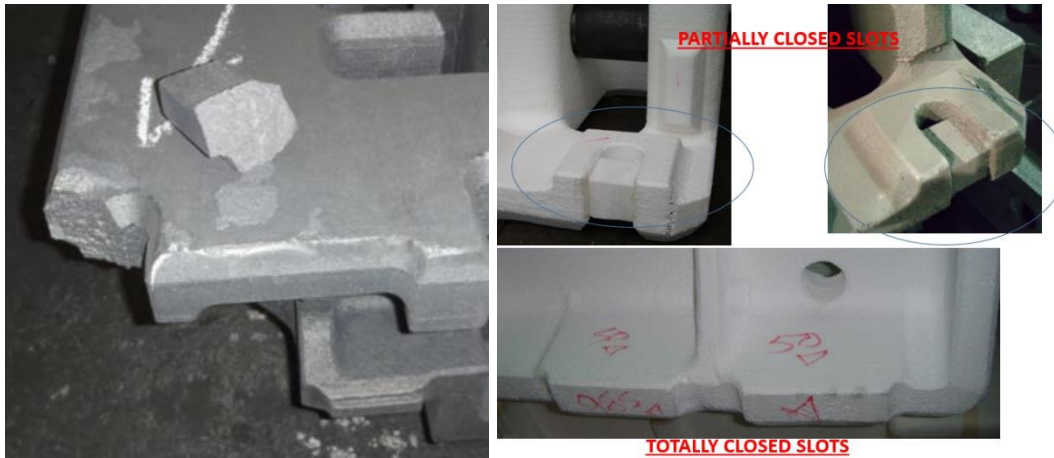
Due to their shape and position, these elements weaken the part's structure.

When designing or manufacturing the models, it must be taken ensured that these elements, as well as the very base origin flange at the ends are sufficiently protected or reinforced so that they have due resistance and do not deform or break in the moulding, mould removal and/or deburring process.

It is recommended that at least the **slots on the ends be closed** on the model for later mechanisation, since if left open, they are excessively fragile in handling the part for mould removal and deburring.

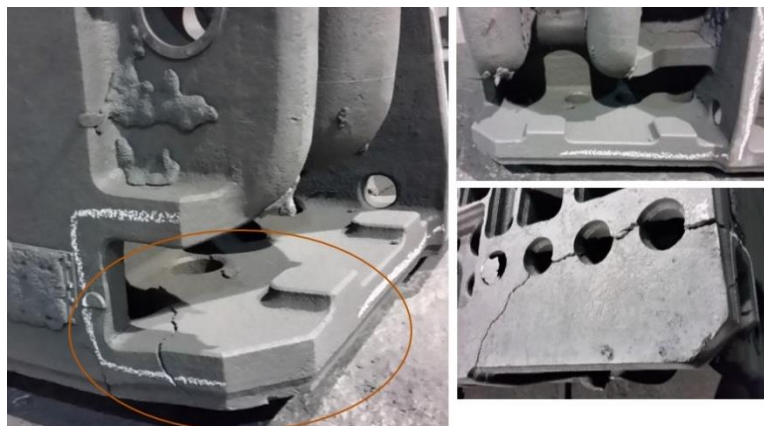
To avoid breakage, the anchoring slots for the die-cut bases must be closed on the models. We recommend that the slots be manufactured totally **closed on the model, or partially closed**.

When the anchoring slots are together, it is recommended to close them on the model, since the strip separating them is very weak.



5.3. Base Settlement

It is recommended that the ends of the base settlement, with anchoring slots or not, be designed in reinforced fashion. In this regard, these areas should never be corbel.



5.4. Forming Roller Holders - Templates for Forming Roller Holders

In order to ensure the straightness and verticality of the forming roller holders, the modeller must deliver, along with the forming rollers, a template with the holes made for the holders. It is recommended that this template come assembled by the modeller. This ensures that it will not break during transport.

- Even though the forming rollers are symmetrical, two templates shall be manufactured. This is because the templates are not recovered once the forming roller is moulded.
- The polystyrene template must be 40 or 50 mm thick, and have as many holes as the forming roller has holders.
- The template's holes will have a diameter that is 4 mm greater than the diameter of the holders.



The holders are very fragile elements, so when designing these elements, we recommend that they be joined together or sized large enough that they are rigid elements.



The holders must not have a diameter less than 80.

The joints for the holders to the forming rollers must always be radial or chamfer, **NEVER A SQUARE CORNER.**

When manufacturing the holders, the modeller must avoid using false elements, and if they are, duly paste and wrap them to prevent them from separating or refractory paint from penetrating the interior



6. Burn-Outs

One of the greatest defects in casting are burn-outs. Generally speaking, this is because the part has hot points which, without a sufficient refractory level, makes the sand burn out and stick to the cast, leading to:

- An increase in part deburring time.
- Sand and refractory paint penetration, making mechanisation difficult.

In order to avoid burn-outs, it is advisable, when designing the parts, that access points (hollows) be as large as possible so that the sand may be pressed with one's hand. In this regard, as follows, examples of designs that are unfavourable for avoiding burn-outs are shown.

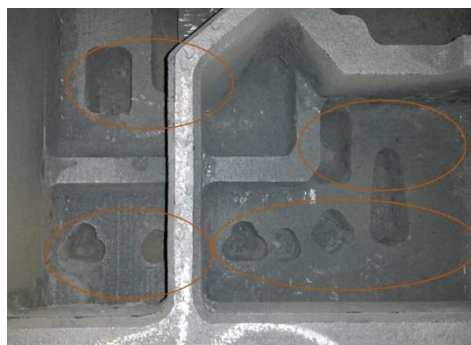
6.1. Remnant Output

Remnant outputs less than 30mm must be left closed in the model, since the sand burns out in narrow passages.



6.2. Remnant Output: Clearances

Avoid carrying out this type of clearance, since it creates burn-outs. In addition to increasing deburring time, these burn-outs create difficulties and an increase in mechanisation time.



6.3. Housing for Column or Guide Bushing

a space was left in the back part and the narrow side that burned out the sand are difficult zones to mould and are impossible to deburr.

To avoid burn-out, these hollows should not have been created.



6.4. Narrow Zones (less than 50 mm)

Hot points have been created and it is difficult to press the sand, so the consequent burn-outs were created. To avoid this, the hollows should be no less than 120 mm.



6.5. Set of Passages and Narrow Clearances

Hot points where it is difficult to press the sand were created. When designing, the possibility of inserting sand must be taken into account.

