Product Design

The following are the important reminders about product design to take advantage of Iupilon/NOVAREX excellent properties.

1. Thickness

The average thickness of the injection-molded product is 1 to 5mm. Generally, product's intensity will increase by growing its thickness, but there is a limitation from a standpoint of moldability. More specifically, the thicker the product, the longer the cool time, which will end up with increased molding cycle. Therefore, thoughtful consideration is necessary when deciding the thickness. (Cool time of the plain plate will increase as the square of its thickness.)

Some points about thickness when designing:

Achieve uniformity in thickness by recessing. (Figure 1)
Avoid drastic change in thickness. (Figure 2)
Use rib structure at a part would be thick. (Figure 3)
Keep distance from hole to hole, and from hole to edge. (Figure 4)

Figure 1

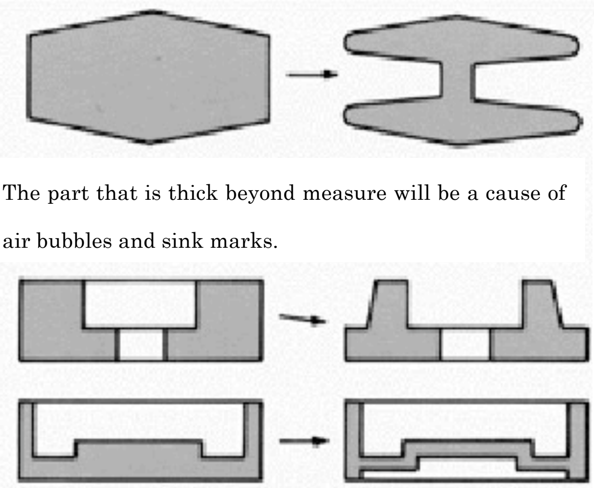
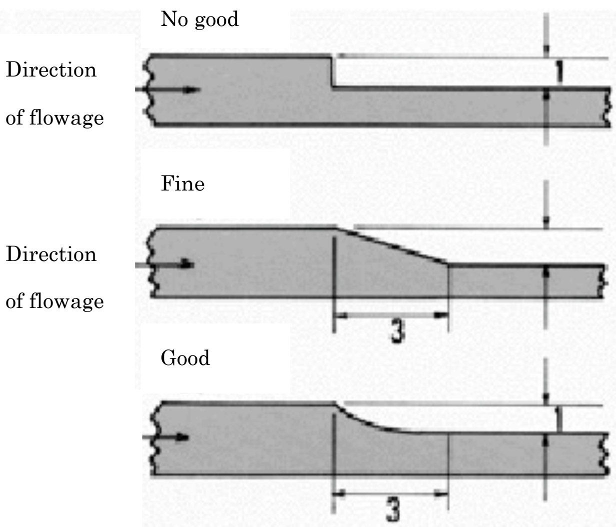
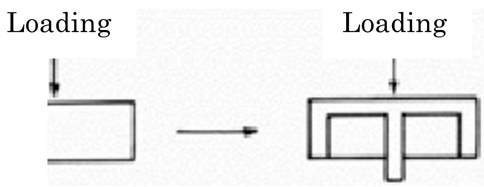


Figure 2



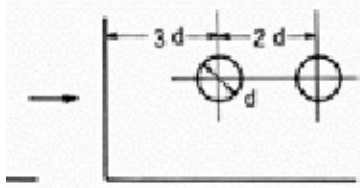
Make a slow change in the thickness.

Figure 3



Put a rib on the direction of the load.

Figure 4



Set apart hole from the edge and another holes.

2. Corner Radius

The corner part of molded product will be overstressed by the concentration of stress, so do not forget making it round.

The relation of Iupilon/NOVAREX notch radius and impact value is indicated in Figure 5. In cases where radius is below 0.1mm, brittle fracture is indicated.

Avoid sharp corners and make it round more than 0.3mm radius when designing. (Radius of more than 0.5mm is preferred) (Figure 6 and Figure 7)

Figure 5 Iupilon/NOVAREX notch radius and impact value

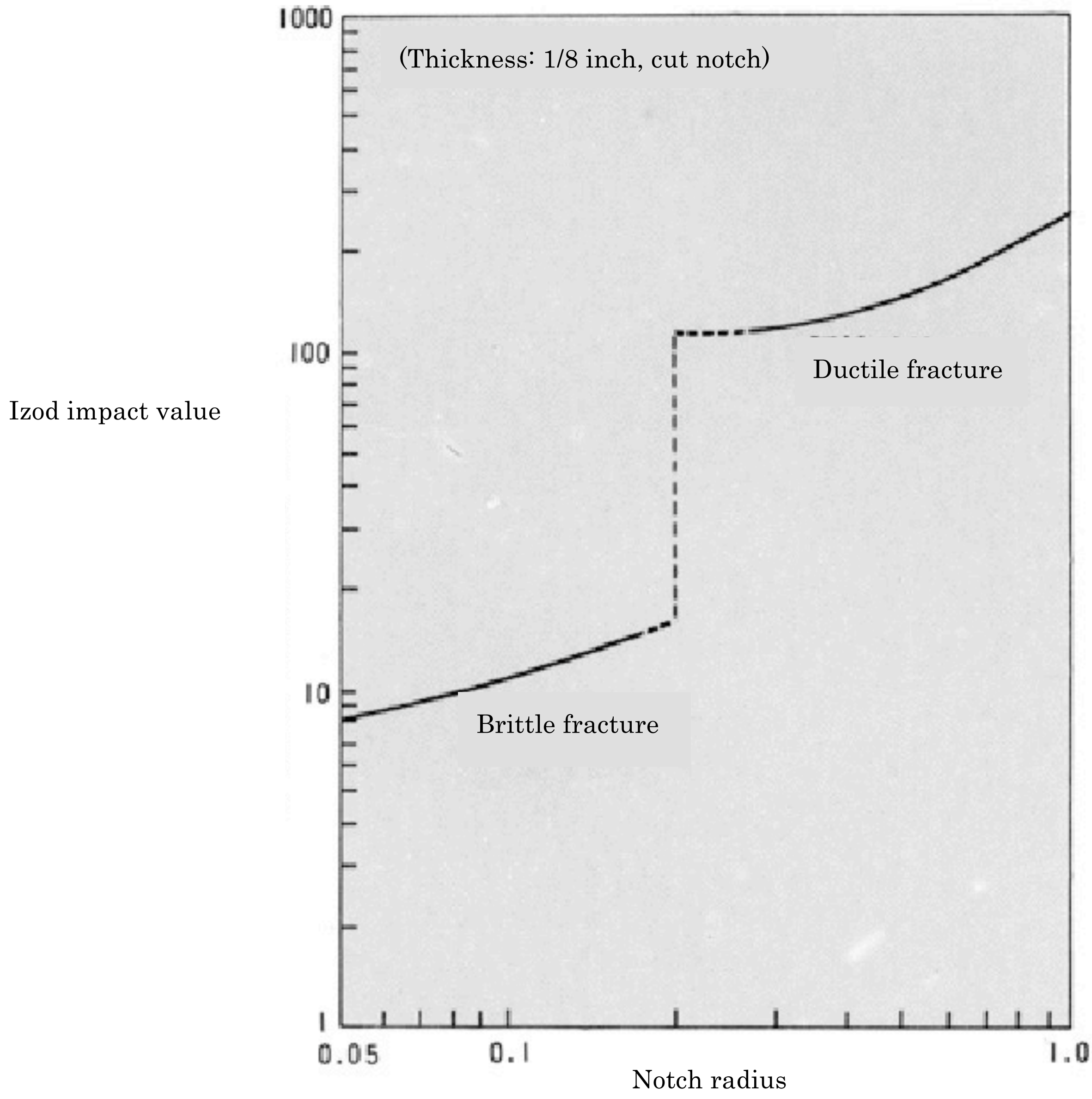
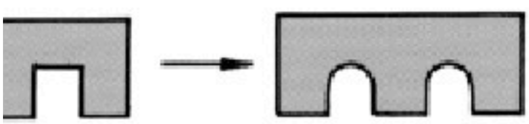


Figure 6



Make square window round

Figure 7

Make chest region round.

3. Rib

Designing of thickness is often accompanied by sink marks and void, so sometime it is difficult to keep its design intensity. In such case, making it rib structure is effective.

Some points about rib structure when designing:

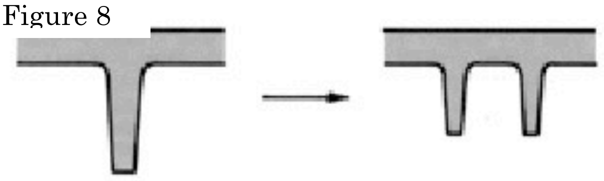
Instead of one big rib, make it small and many. (Figure 8)

Link the ribs and make it in a reticular pattern for further intensity (Figure 9)

Rib must be thinner than the base material. (Figure 10)

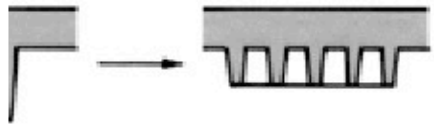
Put verge ribs on the base, top, and around the hole of the molded product for further intensity. (Figure 11 to 14)

Figure 8



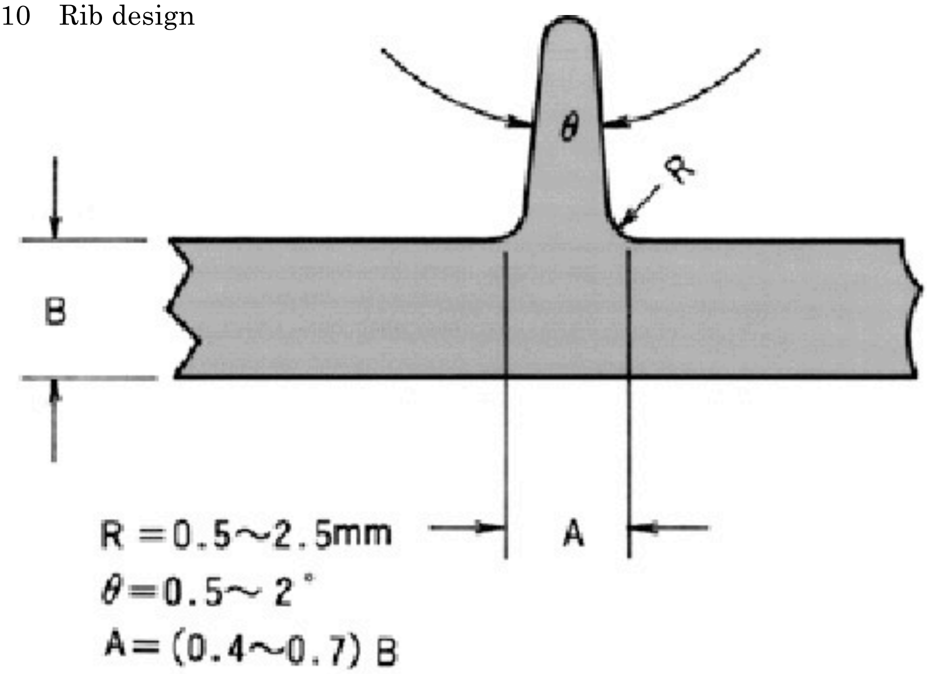
Make the rib small.

Figure 9



Make the rib lattice-shaped and linked.

Figure 10 Rib design



Make the root round and put a draft angle.

Figure 11　Corner rib design

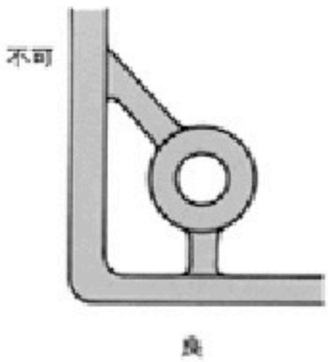


Figure 12

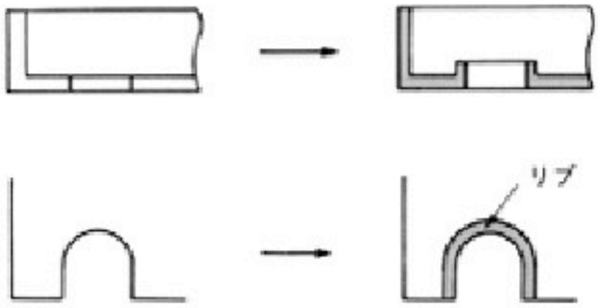
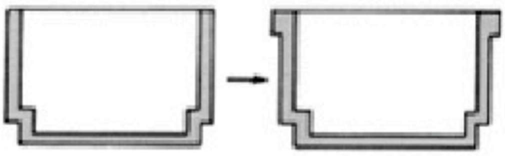
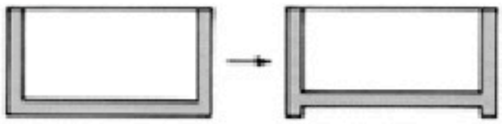


Figure 13



Put a verge rib on the upper part of the box.

Figure 14



Put a verge rib on the base of the box.

4. Boss

Boss functions as an assemblage of the molded product, and is used in a self-tapping screw mounting press fit. If boss is too thick or the root radius is too round, it will be the cause of sink marks and air bubbles, which will end up with poor appearance and strength reduction. As shown in Figure 15, equalizing the thickness by recessing is necessary.

If boss for self-tapping screw is too big, there will be sink marks on the surface of the molded product, and if it is too small, when screwing the self-tapping screw, it might cause crack. General design example of boss for self-tapping screw is shown in Figure 16.

Figure 15 Recessing boss

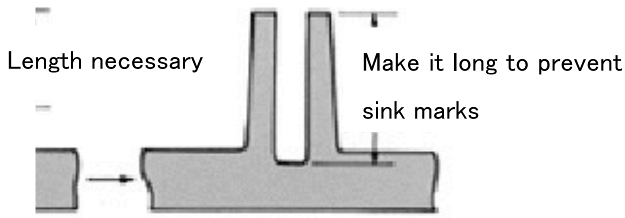
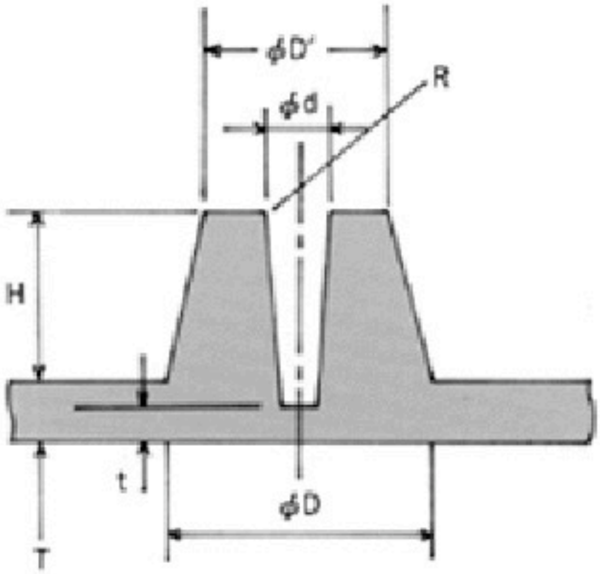


Figure 16 Design of boss for self-tapping screw



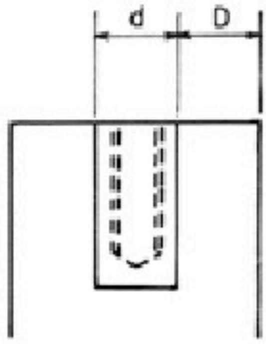
Screw	φ 3	φ 5
D	φ 7	φ 11
d	$\phi\ 2.3^{+0.1}_{-0.05}$	$\phi\ 4.3^{+0.1}_{-0.05}$
R	0.5 ～ 1	0.5 ～ 1
t	1.0 ～ 1.5	1.0 ～ 1.5

Draft angle of exterior

$$\frac{D-D'}{2H}=\frac{1}{30}\sim\frac{1}{20}$$

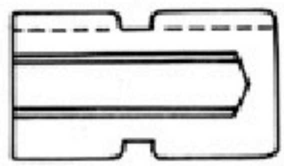
Boss is difficult to pull out, so the draft angle must be set big. However, if the boss is too tall, the base area will be big and can cause sink marks and air bubbles, so be careful.
The height of boss for self-tapping screw is about 30mm in general.
Design of metal insert and screw shut is shown in **Figure 17** and **Figure 18**.

Figure 17　Design of metal insert



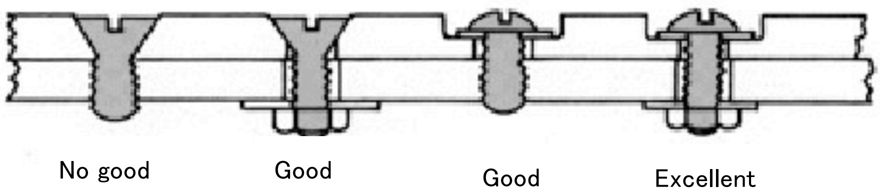
D : Thickness of the product

d : Radius of metal screw



Knurling is disapproved. Cut a gash in the barb end and the spin lock.

Figure 18　Design of screw shut

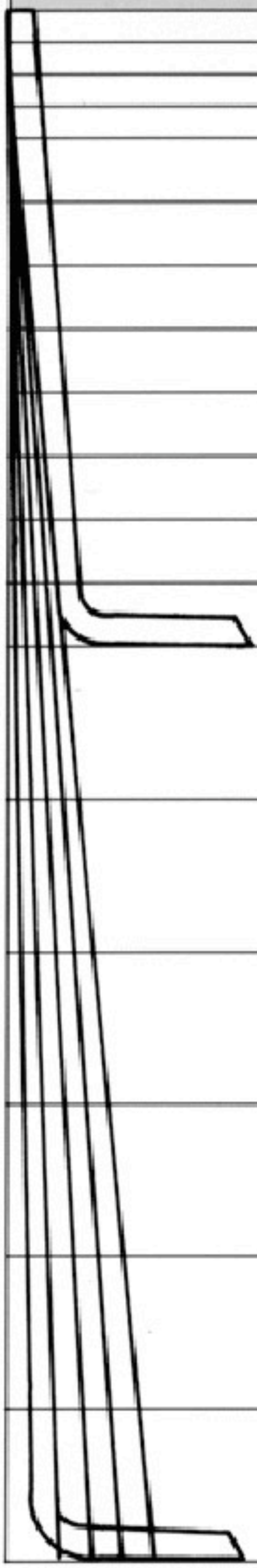


5. Draft angle

To bring out the mold from molded product easily, there need to be draft angle in molded product under the mold. Draft angle can be shown in tilt modulus (S/H in Figure 19) or by angular degree.

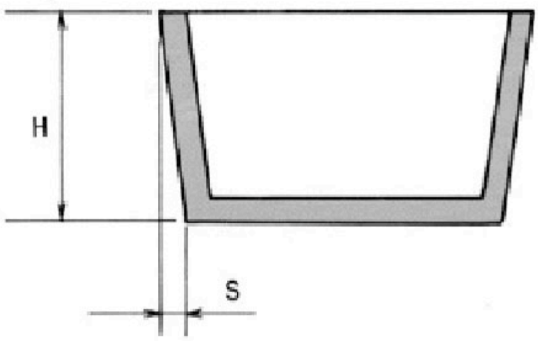
Quick reference is indicated in Table 1.

Table 1　Quick reference of draft angle



mm	0.5°	1.0°	2.0°	3.0°
5	0.0436	0.0873	0.1746	0.2620
10	0.0873	0.1746	0.3492	0.5241
15	0.1309	0.2618	0.5238	0.7861
20	0.1745	0.3491	0.6984	1.0482
30	0.2618	0.5237	1.0476	1.5722
40	0.3491	0.6982	1.3968	2.0963
50	0.4363	0.8728	1.7460	2.6204
60	0.5236	1.0473	2.0952	3.1445
70	0.6109	1.2219	2.4445	3.6685
80	0.6981	1.3964	2.7937	4.1926
90	0.7854	1.5710	3.1429	4.7167
100	0.8727	1.7455	3.4921	5.2408
125	1.0909	2.1819	4.3651	6.5510
150	1.3090	2.6183	5.2381	7.8612
175	1.5272	3.0546	6.1111	9.1714
200	1.7454	3.4910	6.9842	10.4816
225	1.9635	3.9274	7.8572	11.7918
250	2.1817	4.3638	8.7302	13.1019

Figure 19　Draft angle



Iupilon/NOVAREX draft angle

In general, 1/2° to 2° in angular degree (1/20 to 1/30 in tilt modulus) is standard.
(In the case of some precision instrument, the standard value can be 1/4 to 1/2)
Standard draft angle of engineering plastic is shown in Table 2.
(Draft angle will differ by the molded product's shape, mold construction, and surface finishing.)

Table 2　Standard draft angle of engineering plastic

	Type of plastic	Unreinforced grade	Reinforced grade
Crystalline	Nylon	more than 1/8	1/4 ～ 1
	Polyacetal	1/4 ～ 1/2	1/2 ～ 1
	PBT, PET	1/4 ～ 1/2	1 ～ 2
Noncrystalline	Modified PPE	1/4 ～ 1/2	1 ～ 2
	Polycarbonate	1/2 ～ 2.0	1 ～ 2

6. Draft angles of parts

Box or lid

In the case of box shape, put cavity side's draft angle bigger than the core side's so that external side, in other words cavity side, is easy to pull out. Standard value is indicated in Table 3.

Figure 20 Design of the draft angle in box shape

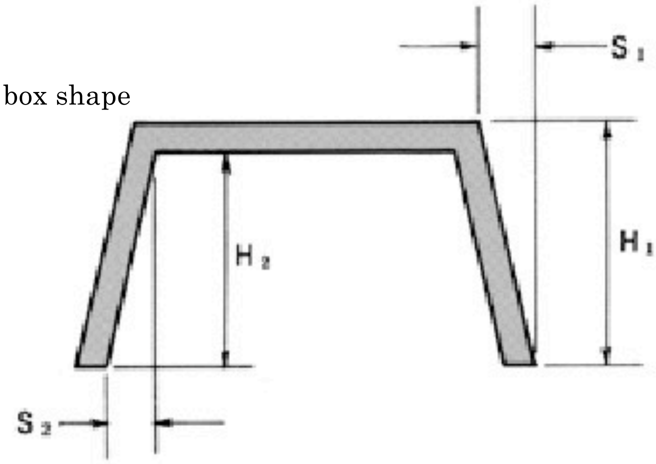


Table 3 Draft angle of box shape

H_1	～50	50 to 100	100～
Internal side S_1/H_1	1 / 30	1/40	1/50
Internal side S_2/H_2	1/40	1/50	1/60

Rib's standard draft angle is shown in Figure 21 and 22, but the tip of the rib (Thin part that is made by draft angle) is preferred to be more than 1mm in thickness for easier die machining.

Figure 21 Design of the draft angle in longitudinal rib

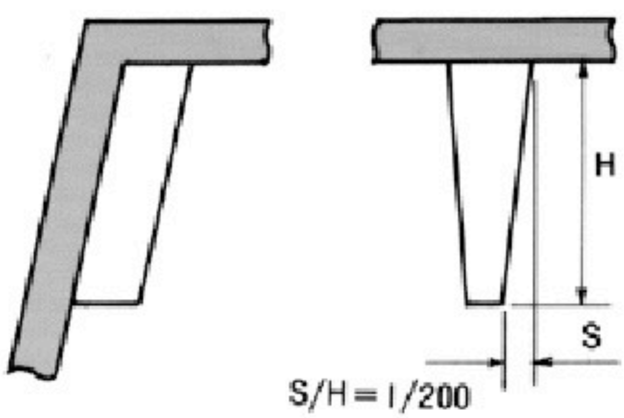
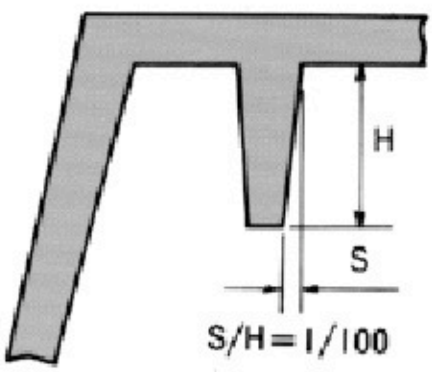


Figure 22 Design of the draft angle in base rib



Boss

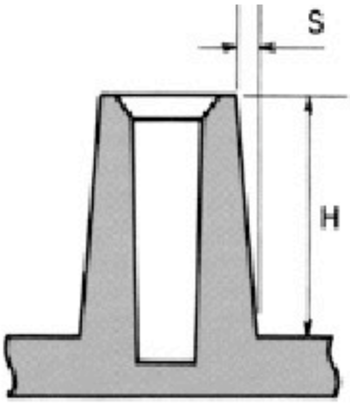
Boss is difficult to pull out, so the draft angle must be set big. However, if the boss is too tall, the base area will be big and can cause sink marks, so attention is necessary.

The height of boss for normal self-tapping screw must be about under 30mm.

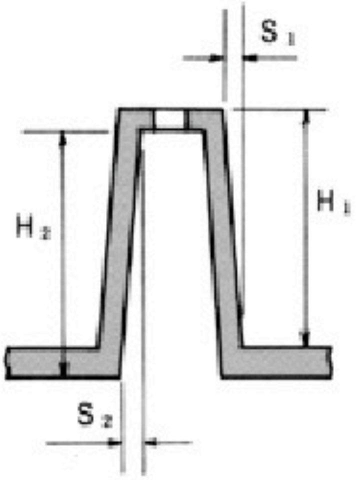
Boss's standard draft angle is shown in Figure 23

Figure 23 Design of the draft angle in boss

<Boss for self-tapping screw>



$S/H=1/30\sim1/20$



<Dent hole>

$S_1/H_1=1/50\sim1/30$

$S_2/H_2=1/100\sim1/50$

Texture pattern

The way to pull out will differ by the texture pattern's type, depth, direction, and processing method, but the problem is, would the texture pattern be undercut towards the direction of pulling out or not.

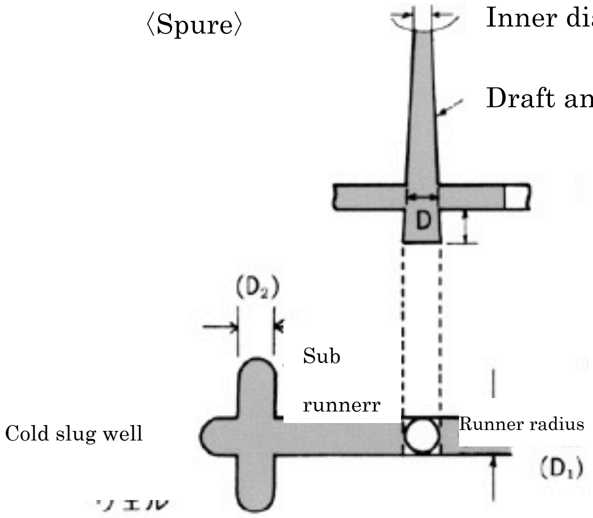
Especially, texture pattern of lateral side can cause scratch on molded product, so attention is necessary. In general, 3° to 5° of draft angle is necessary, depending on the roughness of the texture.

7. Sprue and runner

The shape of the sprue and the runner will differ by the size of the molding machine using, but it is quite an important factor for designing molds. General design example is shown in Figure 24.

Figure 24　Design of the sprue and the runner

〈Spure〉



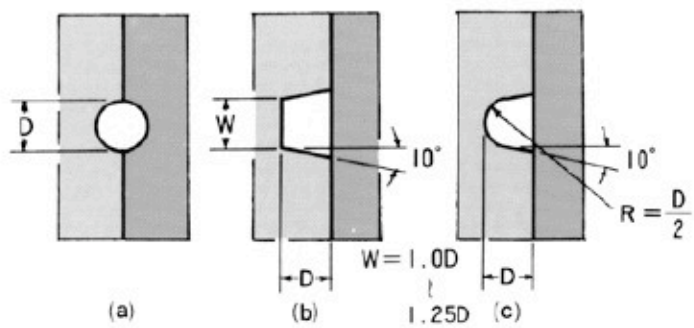
① In general, length of the cold slug well (S) should be 1.5 to 2.0 times longer than the runner radius.

② Sprue bottom radius (D)≧Runner radius (D1)≧Sub runner radius (D2)

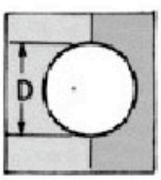
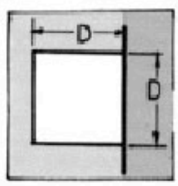
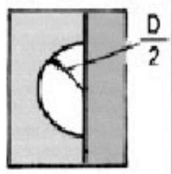
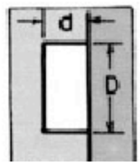
〈Runner〉

Normally, runner that has cross-section shape shown below should be used.

(a)Round shape　(b)Trapezoid　(c)Quasi-semicircular shape



〈Runner cross-section area shape efficiency〉

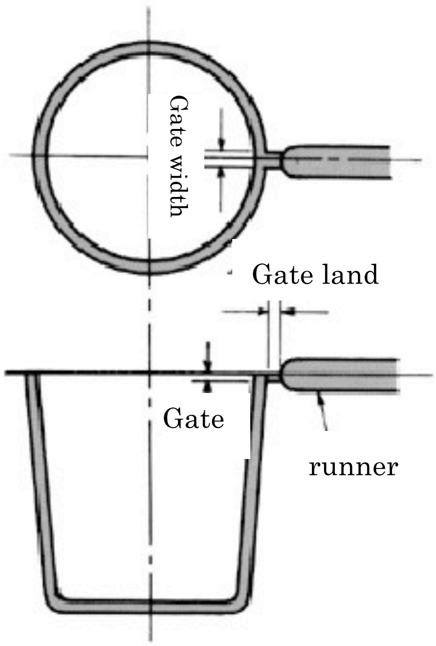
Runner cross-section surface	 Round	 Horny	 Semicircle	 Short shape	
Area / Ratio *Circumference	0.25D	0.25D	0.153D	d = D/2	0.166D
				d = D/4	0.1D
				d = D/6	0.071D

8. Gate

Gate form will differ by the shape of the molded product, but the general gate form is shown in Figure 25 to Figure 32.

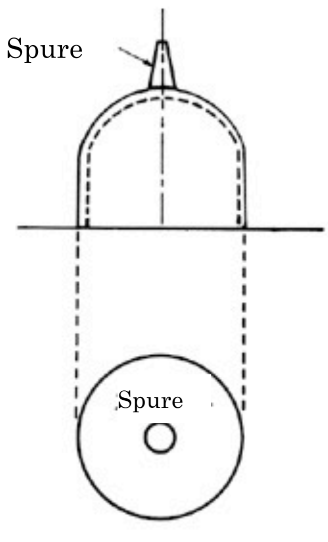
(1) Side gate ・・・ General gate form.
Gate thickness should be 50% to 80% of molded product's thickness. Molded product's thickness must be larger than the gate's thickness.

Figure 25 Side gate



(2) Direct gate ・・・ Type which fills melting plastic directly to cavity from sprue. This type is used to avoid making weld in semicircle or box shaped molded product.

Figure 26 Direct gate Sprue

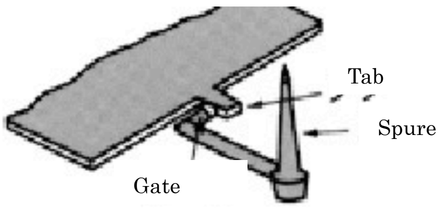


(3) Tab gate ・・・ This gate is for lessening the fault phenomenon around the gate such as jetting and tarnish.

Tab thickness should be 70% to 100% of molded product's thickness.

Also, gate thickness should be 50% to 80% in general.

Figure 27 Tab gate



(4) Film gate

Fan gate ・・・ This type is for molded product which has wide gate. Gate thickness should be 50% to 80% of molded product's thickness.

Figure 28 Film gate

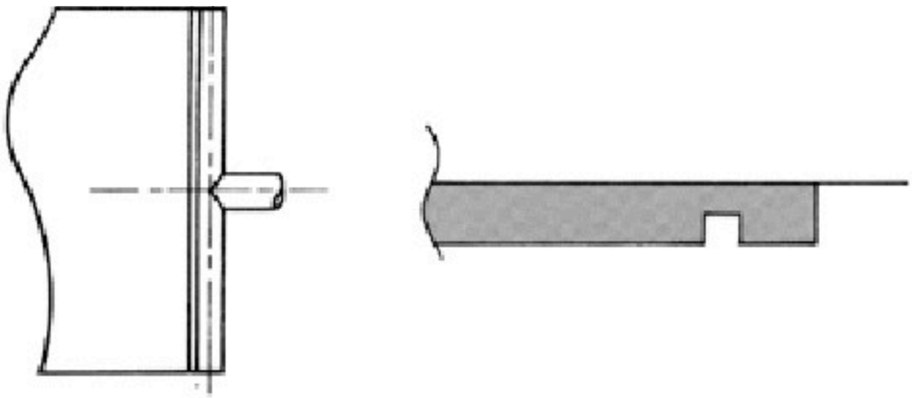
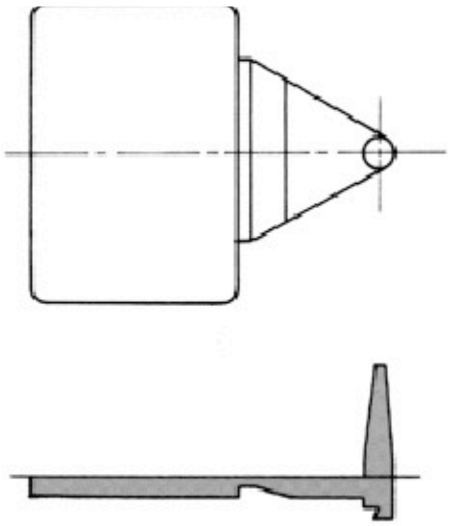
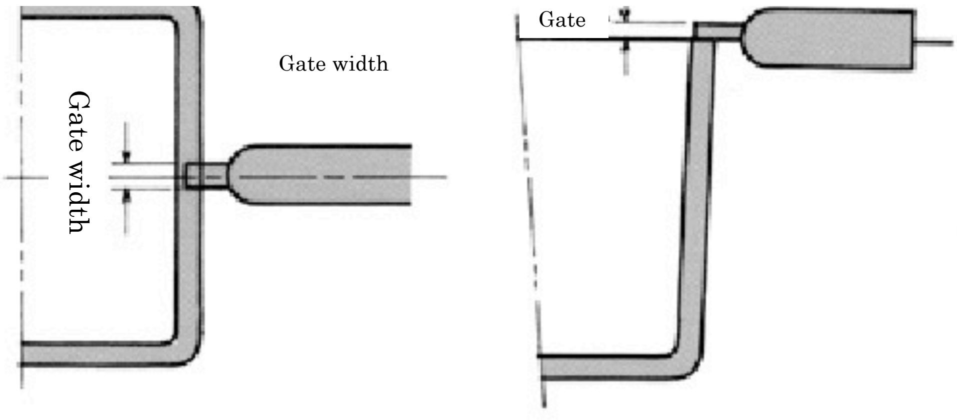


Figure 29 Fan gate



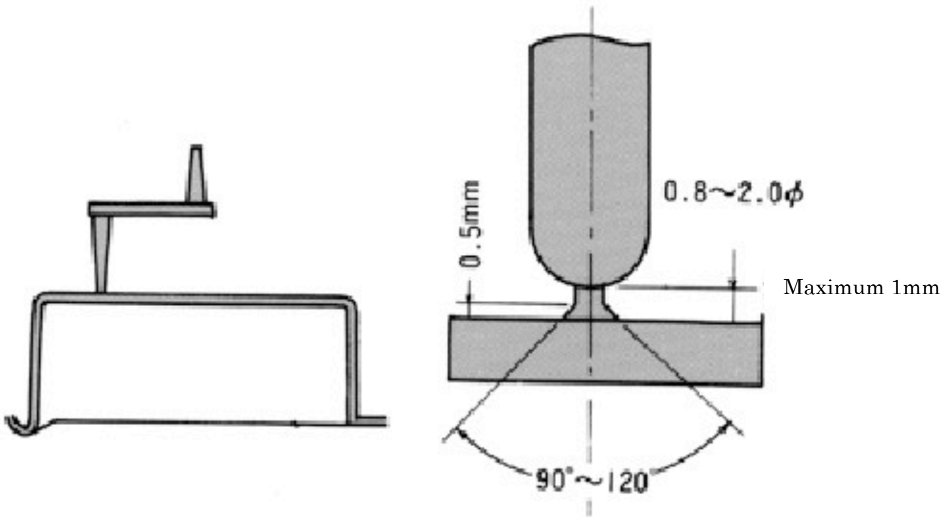
(5) Overlap gate ・・・ This is one kind of a side gate and used to avoid gate marks on the external surface of molded product.

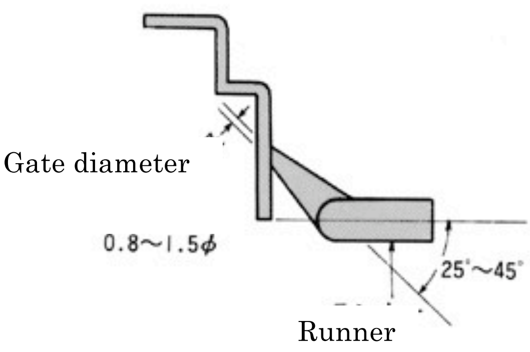
Figure 30 Overlap gate



(6) Pinpoint gate

Submarine gate ・・・ This is used to avoid gate marks and this will run automatically when gate cut opens the mold tool.

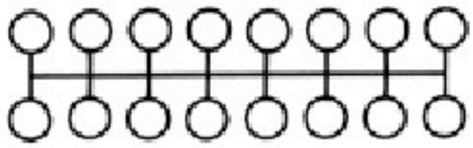




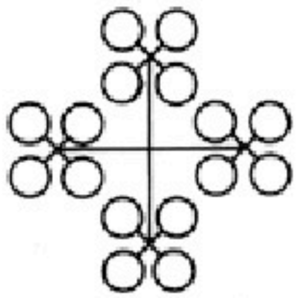
9. Runner balance

In case of multi impression mold, make the runner length, sprue to mold cavity, the same so that each cavity can fill plastic equally.

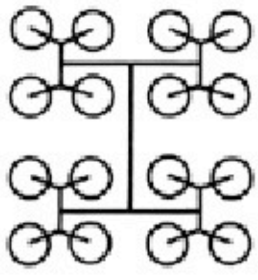
Runner balance: Plastic flowing in each cavity at the same time.



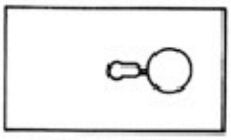
No good



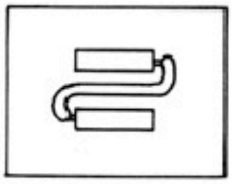
Good



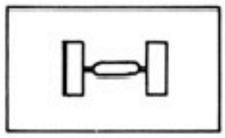
Good



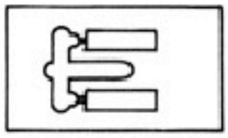
Single



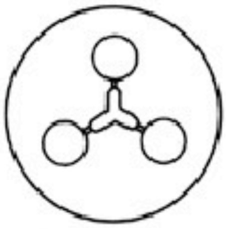
Double



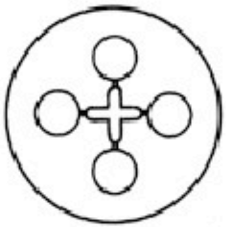
Double



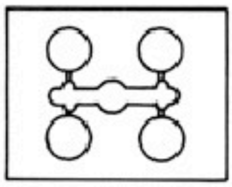
Double



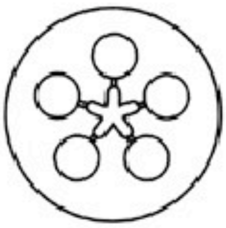
Triple



Quadruple



Quadruple



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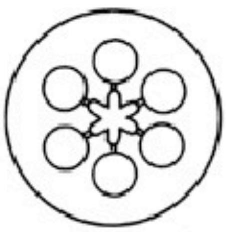

Sextuple