Metrology, standardization and certification

Theme 10: Accuracy rationing of metric thread joints

Lecture plan:

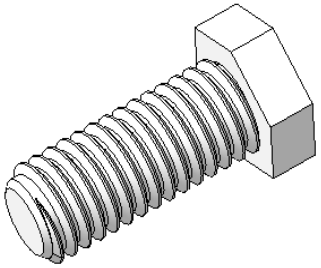
1. General information about thread.
2. Normalized parameters of the metric thread.
3. Compensation of a pitch error.
4. Compensation of a profile angle error.
5. Tolerance zones for the metric thread.
6. Designation of the thread joints in drawing.

General information about thread

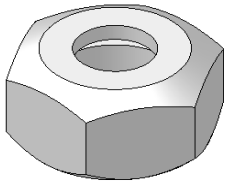
Threaded joints are widely used in the construction of machinery, apparatus, instruments, tools and devices in various industries. In the majority of modern machines for over 60% of all parts have threads

Threaded joint is a connection of two parts using threads, ie elements of the details having one or more helical projections of constant cross-section arranged uniformly on the side surface of the cylinder or cone.

External thread for brevity is called a **bolt (screw)** and the internal thread - **a nut.**



Bolt (screw)



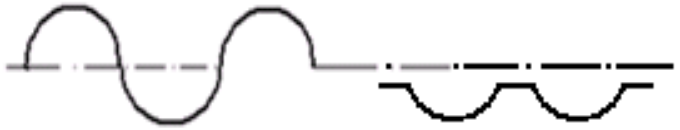
Nut

General information about thread

Thread profile is called the common contour section of the grooves and projections in the longitudinal plane passing through the axis of the thread for external and internal threads.

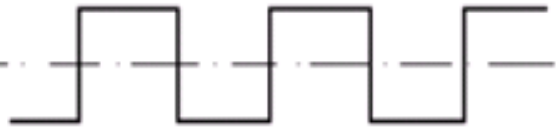
Depending on the profile, ie from the type of cross-sectional figure, thread can be classified as follows:

Triangular thread



Round thread

Trapezoidal thread



Square thread

Buttress thread

Pipe thread

General information about thread

Also, thread can be classified as follows:

On the basis of hand:

-Left handed

-Right handed

On the basis of purpose:

-Fastening

-Translation

-Special

On the basis of starts:

-Single start thread

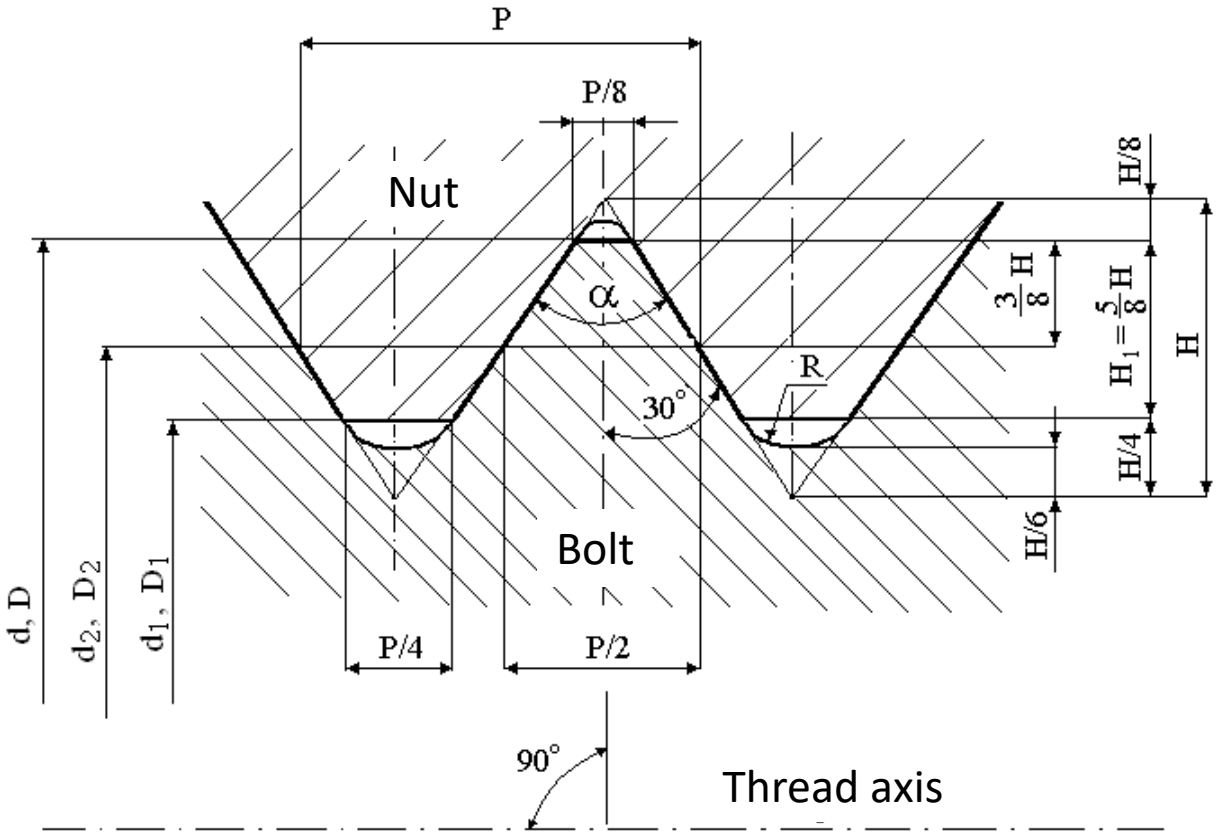
-Multi start thread

On the basis of surface form:

-Straight

-Tapered

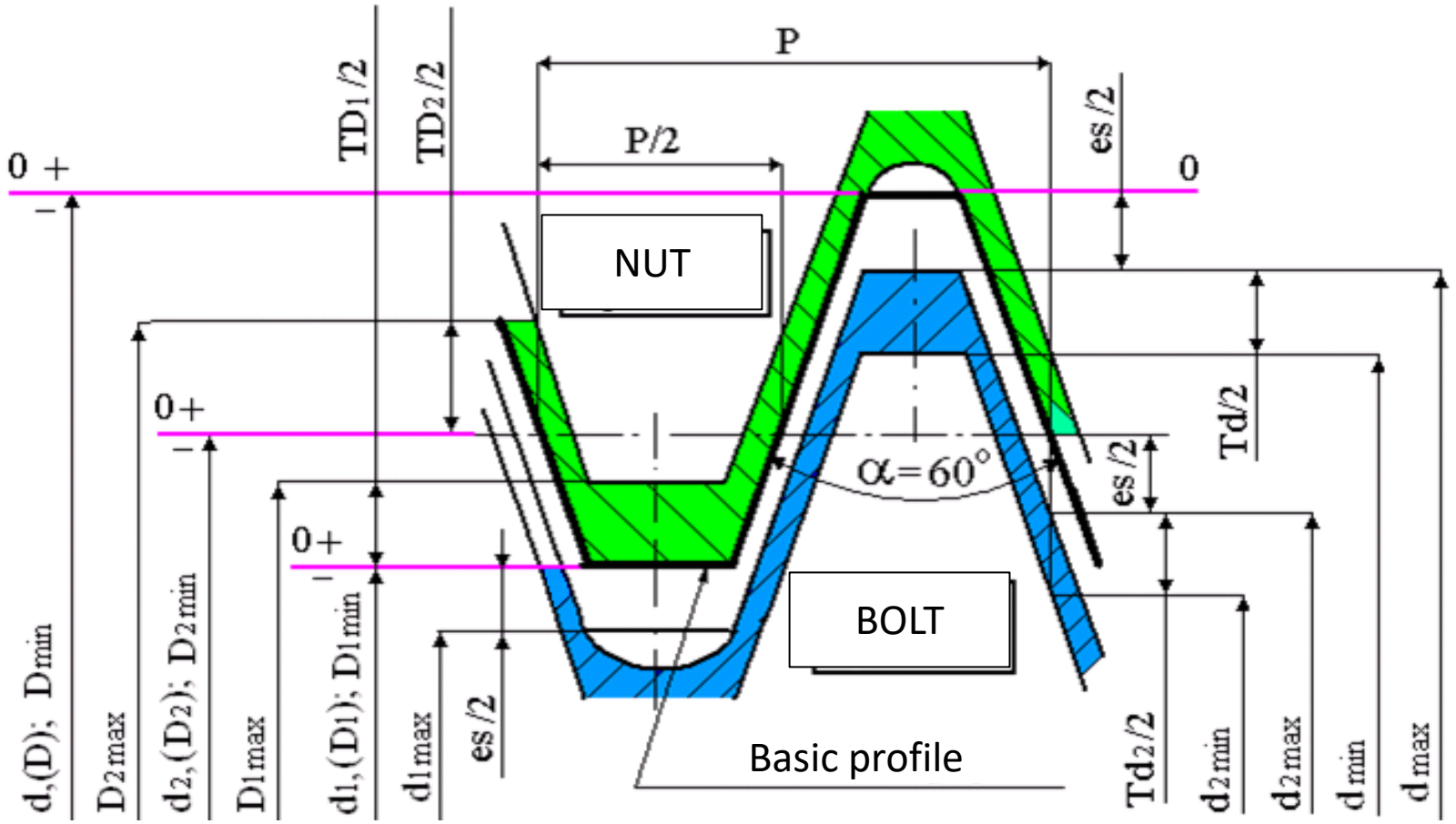
Normalized parameters of the metric thread



Profile of metric thread and its general parameters

H - height of the original profile; **H_1** - working height profile; **P** - thread pitch; **α** = 60 ° - angle of the thread profile; **d, D** - outer diameter of the thread of the bolt and nut; **d_1, D_1** - inner diameter of the thread of the bolt and nut; **d_2, D_2** - pitch diameter of the thread of the bolt and the nut; **R** - the nominal radius of the bolt cavity.

Normalized parameters of the metric thread



Location of the tolerance zones for metric thread when landing with a clearance

Normalized parameters of the metric thread

For metric threads standardized accuracy of the following elements:

-Outer diameter of the bolt (Td) ,
- The inner diameter of the nut (TD_1) ,
- Pitch diameter of the bolt and nut (Td_2, TD_2)

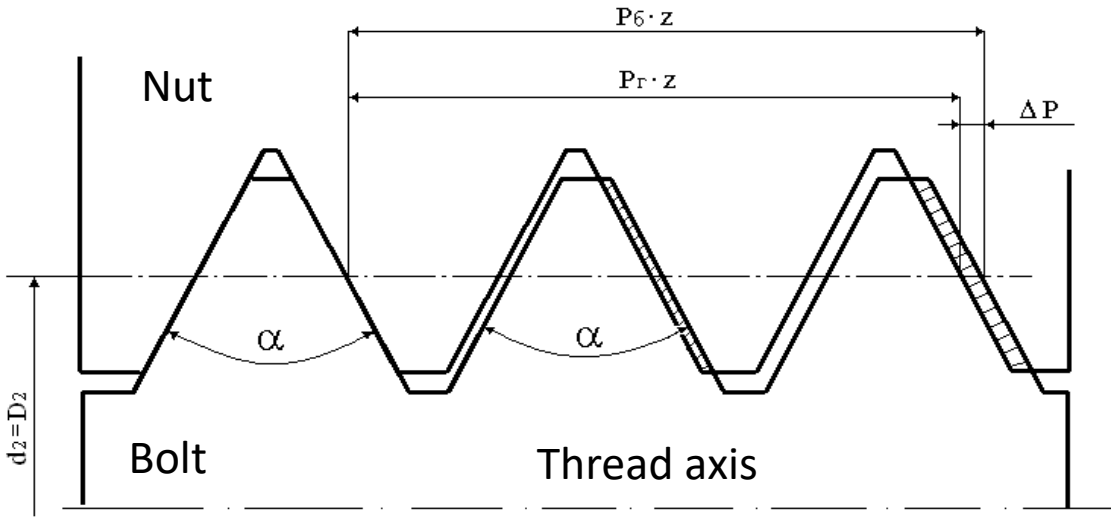
For metric threads are not standardized requirements for accuracy of pitch (P) and thread angle (α). This is because the accuracy of the valuation of these elements is associated with a pitch diameter (d_2, D_2). Tolerance is the cumulative pitch diameter, i.e. it includes not only the pitch diameter tolerance, and also the profile angle compensation error (**fα**) and the thread pitch compensation error of manufacturing (**fp**).

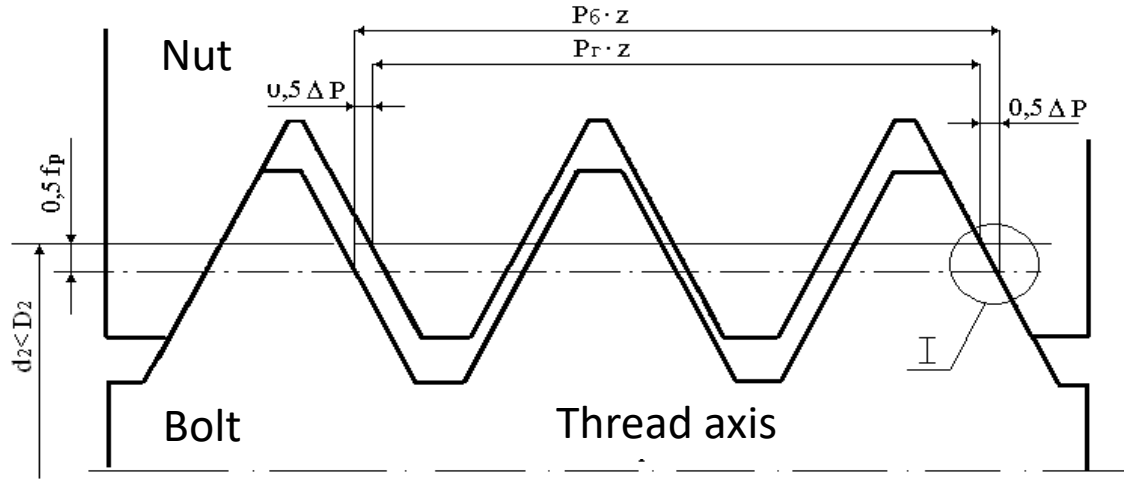
The total tolerance for a pitch thread diameter:

$$\mathbf{Td_2\ (TD_2) = T'd_2\ (T'D_2) + fp + f\alpha,}$$

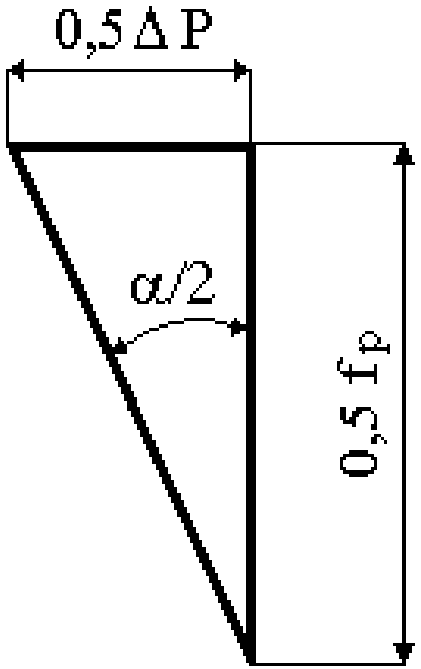
$\mathrm{T'd_2\ (T'D_2)}$ – tolerance only for a pitch diameter.

Compensation of a pitch error





Compensation of a pitch error

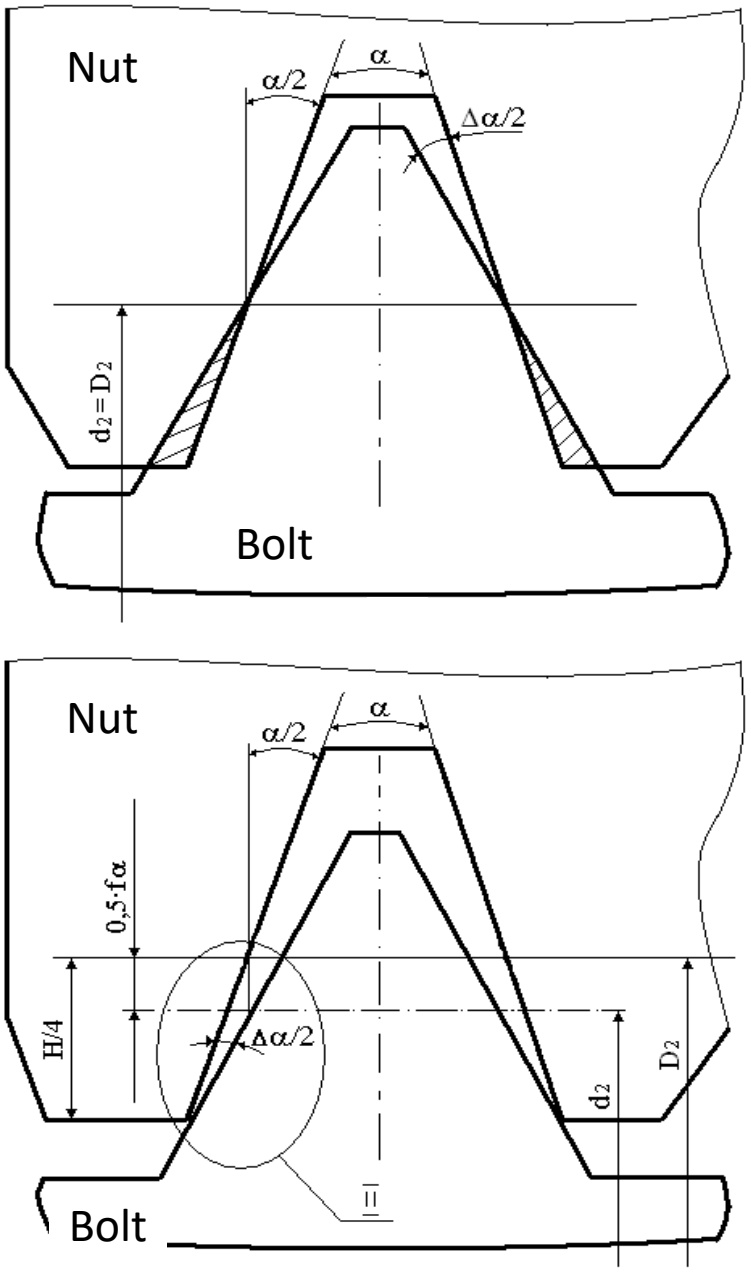


$$ctg(\alpha/2) = 0{,}5\ fp\ /\ 0{,}5 \cdot \Delta P,$$

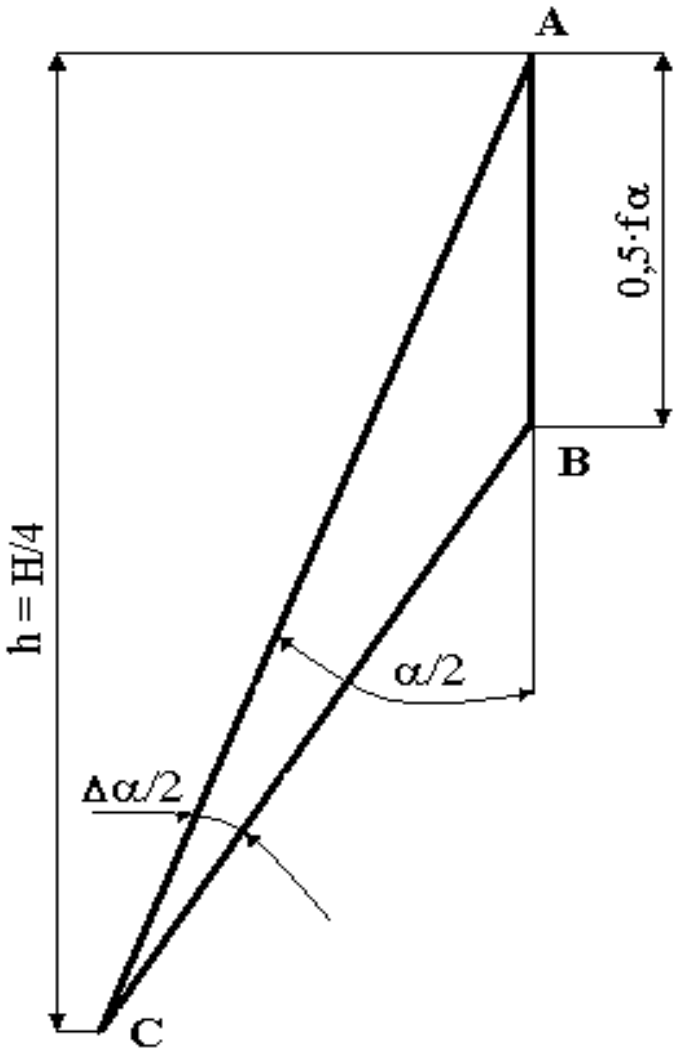
$$fp = \Delta P \cdot ctg(\alpha/2),$$

$$\mathbf{fp = 1{,}732 \cdot \Delta P}$$

Compensation of a profile angle error



Compensation of a profile angle error



Applying the sines theorem, we get:

$$\frac{AB}{AC} = \frac{\operatorname{Sin}\left(\frac{\Delta\alpha}{2}\right)}{\operatorname{Sin}\left[180 - \left(\frac{\alpha}{2} + \frac{\Delta\alpha}{2}\right)\right]},$$

$AB = 0{,}5 \cdot f\alpha,$
$AC = h/\cos(\Delta\alpha/2).$

After all transformations obtain for metric threads:

$$\mathbf{f\alpha \approx 0{,}36 \cdot P \cdot \Delta\alpha/2,\ \mu m,}$$

$\Delta\alpha/2$, min.

Clearance in the threaded joint

The value of the ***virtual diameter of the internal thread of the nut*** is calculated by:

$$D_{2Virt} = D_{2act} - fp - f\alpha,$$

$\mathbf{D_{2act}}$ - the actual (measured) value of the average diameter of the nut, mm

The value of the ***virtual diameter of the external thread of the bolt*** is calculated by:

$$d_{2virt} = d_{2act} + fp + f\alpha,$$

$\mathbf{d_{2act}}$ - the actual (measured) value of the average diameter of the bolt, mm

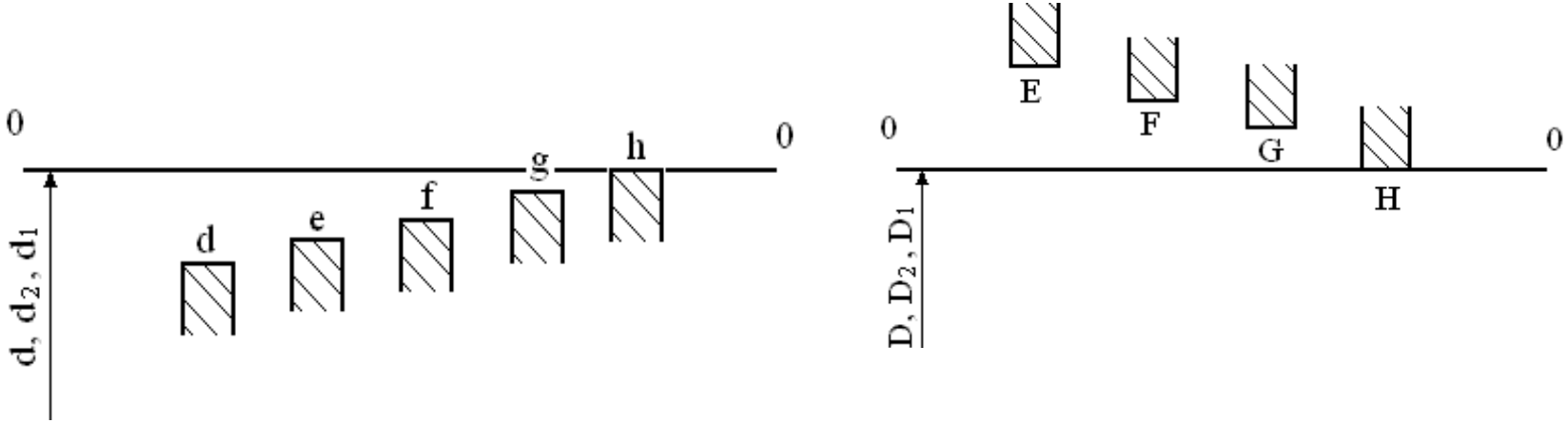
The clearance in the threaded joint is determined by the formula:

$$S = D_{2virt} - d_{2virt.}$$

Tolerance zones for the metric thread

The fundamental approach to rationing of accuracy thread elements and them connections similar for rationing of the smooth components, but it has its own peculiarities.

Fundamental deviations for thread elements are designated in the same manner as for the smooth part elements: uppercase letters on the nut (E, F, G, H) and lower case on the bolt (d, e, f, g, h). Although the magnitude of these deviations are not the same for threaded and smooth parts.



Fundamental deviations for thread clearance fits.

Fundamental deviations are normalized for thread according to GOST 16093-2004 in much smaller quantity than for smooth elements.

Tolerance zones for the metric thread

For the ***outer diameter of the bolt*** (d) is normalized 4th, 6th and 8th degree of accuracy, and for the ***pitch diameter*** (d_2) - from 3 rd to 10th degree.
For ***nut inner diameter*** (D_1) is normalized from 4th to 8th degree, while the ***pitch diameter*** (D_2) from the 4th through 9th degree.

The degree of accuracy in threaded joints specified before the fundamental deviation of the tolerance: **6H; 7f.**

Accuracy class	Screwing length	Bolt	Nut
Precise	**S** **N** **L**	4g; 4h	4H 4H5H; 5H 6H
Average	**S** **N** **L**	5g6g 6d; 6e; ; **6g;** 6h; 7g6g	5H 6G; **6H;** 7H
Rough	**N** **S**	8g	7G;7H 8H

S – short (<2,24 · P · d ^{0,2})
N – normal (2,24 · P · d ^{0,2} ... 6,7 · P · d ^{0,2}),
L – long (>6,7 · P · d ^{0,2}).

Designation of the thread joints in drawing

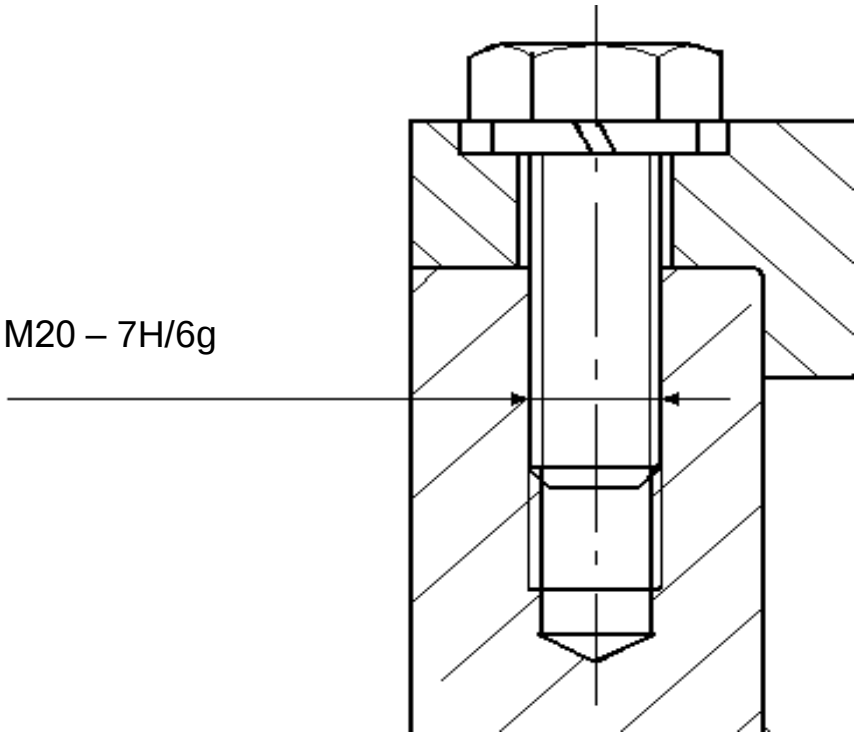
Full designation of thread joint:

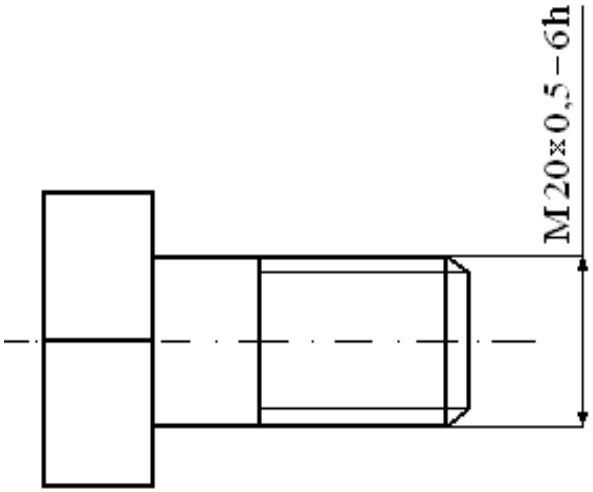
M20 x 0,75 LH – 4H5H/4g4h – 15

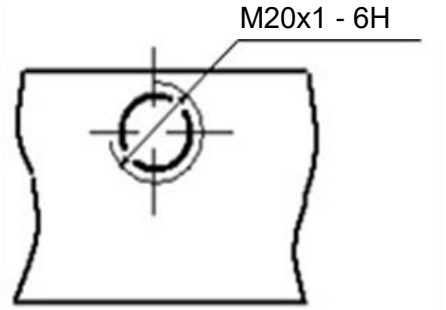
Short designation of thread joint:

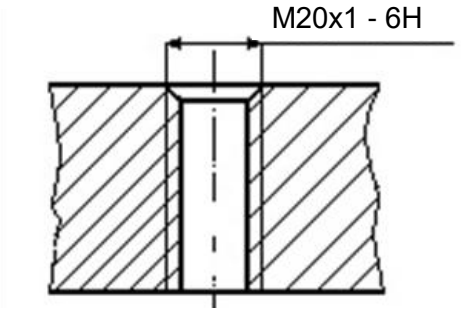
M20 –7H/6g.

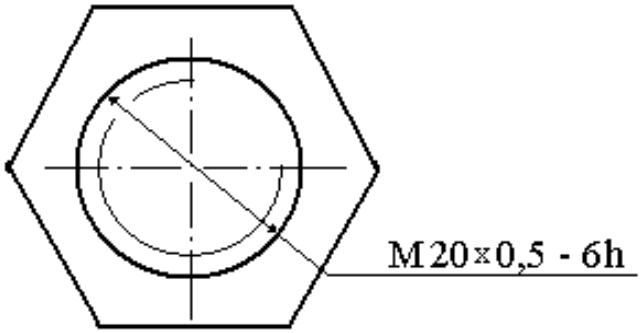
Designation of the thread joints in drawing











Thank you for attention