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**Self-tapping screw connections - Specification of the pilot hole
diameter and tightening torque**

自攻螺钉连接 底孔直径和拧紧扭矩技术条件

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1 Scope

The document lays down the pilot hole diameter of self-tapping screw connections for different sheet thicknesses and different material strengths, and provides the calculation explanation for determining and classifying the tightening torque.

It applies to connections between self-tapping screws of thread size ST2.2 to ST9.5 conforming to GB/T 5280 and metal materials of the specified strength.

2 Normative references

Two documents are cited: GB/T 3098.5, Mechanical properties of fasteners, Self-tapping screws; and GB/T 5280, Thread for self-tapping screws. For dated references only the edition cited applies; for undated references the latest edition, including any amendments, applies.

3 Terms and definitions

3.1 tumble: phenomenon of unstable wobbling that arises when the screw is driven into the hole in the sheet because the sheet is too thin.

3.2 tumble limit: limiting value of the sheet thickness at which the unstable wobbling arises.

4 Symbols

The symbols used are the following. The letter c is the width of the thread crest, in millimetres. The letter d is the pilot hole diameter, in millimetres, and d with the subscript D

is the clearance hole diameter, in millimetres. The letter d with the subscript 1 is the nominal thread diameter of the screw and d with the subscript 2 the minor thread diameter of the screw, both in millimetres. F with the subscript $Rp0.2$ is the load corresponding to the stress at the minimum yield point or at a specified plastic extension of 0.2 %, in newtons, and F with the subscript S is the fracture load of the part, in newtons.

M with the subscript B is the failure torque required by GB/T 3098.5, in newton metres. M with the subscript O is the over-tightening torque, that is the torque at which the tapped thread is destroyed, in newton metres. M with the subscript S is the driving torque, also called the tapping torque, in newton metres, and M with the subscript T is the tightening torque, in newton metres.

The letter P is the thread pitch, in millimetres. R with the subscript m is the tensile strength of the thin sheet, in megapascals. The letter t is the thickness of the upper and lower sheets in a symmetrical connection, in millimetres; a note adds that a symmetrical connection means a connection of two layers of sheet.

5 Application limits of simple thread connections made with self-tapping screws

5.1 General. In a self-tapping screw thread connection the parts to be joined are only drilled or punched in advance, no internal thread being prefabricated in the hole; the mating internal thread is cut by the self-tapping screw itself during assembly. Both parts to be joined may have a pilot hole, as shown in Figure 1, or only the lower part may have a pilot hole while the upper part has a clearance hole, as shown in Figure 2. Because the parts to be joined differ in thickness, this type of connection has definite application limits. Self-tapping screws are generally not used for preloaded connections.

5.2 Lower limit of the sheet thickness. If the sheet thickness is less than the tumble limit, the self-tapping screw can be driven into a hole of small diameter with no torque value showing, that is at a torque of 0 N.m; in that case the sheet thickness can be calculated from formula (1), which is written in terms of the pitch, the width of the thread crest, the nominal and the minor thread diameter of the screw and the tangent of 30 degrees. Table 1 lists the tumble limits produced when the maximum values of the width of the thread crest and of the nominal and minor thread diameters, determined in accordance with GB/T 5280, are used. To stay well away from the tumble limit and to make sure that the tightening torque is large enough, the lower limit of the sheet thickness shall be at least equal to the pitch.

5.2 Thin sheet measures. Where the sheet is too thin, the tightening torque required can be secured by flaring the pilot hole, as shown in Figure 3, by extruding the pilot hole, as shown in Figure 4, or by forming a helical hole, as shown in Figure 5. In a thread connection using a helical hole, a special tool is needed to make the edge of the hole take a helical shape

whose form matches the lead of the screw. For thin sheet a self-locking nut or a spring clip nut may also be used to make the self-tapping screw connection, as shown in Figure 6, in which case the parts to be joined need a clearance hole.

5.3 Upper limit of the sheet thickness. The upper limit of the sheet thickness shall not exceed 0.8 times the maximum nominal thread diameter of the screw, so that the driving torque does not exceed 50 % of the minimum failure torque laid down in GB/T 3098.5 and so that, while the necessary tightening torque is reached during driving, an adequate safety margin against the failure torque is kept. The limiting values of the sheet thickness are given in Table 1.

5.3 Table 1, sheet thickness limits. Table 1 is headed sheet thickness limits and its values are in millimetres. Its columns are the ten thread sizes ST2.2, ST2.9, ST3.5, ST3.9, ST4.2, ST4.8, ST5.5, ST6.3, ST8 and ST9.5, and its four rows are the pitch, the tumble limit, the lower limit of the sheet thickness and the upper limit of the sheet thickness. The pitches are 0.8, 1.1, 1.3, 1.3, 1.4, 1.6, 1.8, 1.8, 2.1 and 2.1. The tumble limits are 0.35, 0.58, 0.69, 0.63, 0.65, 0.75, 0.91, 0.86, 0.91 and 0.91. The lower limits of the sheet thickness are 0.80, 1.10, 1.30, 1.30, 1.40, 1.60, 1.80, 1.80, 2.10 and 2.10. The upper limits of the sheet thickness are 1.79, 2.20, 2.80, 3.00, 3.38, 3.84, 4.37, 5.00, 6.40 and 7.50.

5.4 Types of self-tapping screw connection. The thickness of the sheet to be joined shall be greater than the pitch of the screw selected; otherwise the thread under the screw head is incomplete and a sufficiently large tightening torque cannot be applied. Where that condition cannot be met, the self-tapping screw connections shown in Figures 3 to 6 may be used.

6 Pilot hole diameter

The pilot hole diameters laid down in the clause have been determined on the following conditions: the simple self-tapping screw connection shown in Figure 2, with a clearance hole in the upper part and a pilot hole in the lower part; a drilled pilot hole; a surface-hardened self-tapping screw without any coating; and a driving torque not greater than 0.5 times the failure torque required by GB/T 3098.5.

If those conditions are not met, the pilot hole diameters of Table 2 to Table 11 do not apply, and reference is made to Clause 8.

For a symmetrical connection the relation between the driving torque and the pilot hole diameter has a decisive bearing on the value of the tightening torque, and it can be described empirically by formula (2), which expresses the driving torque in terms of the nominal thread diameter of the screw, the difference between the pilot hole diameter and the minor thread diameter, the tensile strength of the thin sheet and the sheet thickness. Formula (2) is valid only for surface-polished, surface-hardened self-tapping screws; explanations of conditions differing from that one are given in Clause 8.

The pilot hole diameters of Table 2 to Table 11 have been calculated from those conditions, and where a sheet thickness or a strength that is not listed is used the pilot hole diameter can be calculated from formula (2).

Table 2 to Table 11 each give the pilot hole diameter in millimetres for one thread size. In every one of them the rows are the steel sheet thickness in millimetres and the columns are the minimum tensile strength of the material in megapascals, in the nine steps 100, 150, 200, 250, 300, 350, 400, 450 and 500. The pages read carry Table 2 for ST2.2, Table 3 for ST2.9, Table 4 for ST3.5, Table 5 for ST3.9, Table 6 for ST4.2 and Table 7 for ST4.8. In all of these the body of the table is laid out with cells merged across several thickness rows at once, so that a single diameter value covers a band of thicknesses whose extent differs from column to column; the individual values have not been transcribed here, because the merged cells cannot be paired with the thickness rows with certainty on the scanned pages.