8 Push-in joints

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8 Push-in joints

Push-in joints act as axially movable joints and are able to withstand high loads. They remain leak tight even when the pipes are non-aligned or angularly deflected to the maximum extent.

8.1 General

For hundreds of years now, cast iron pipes have been fitted together with push-in joints to form pipelines. Modern-day push-in joints **(Fig. 8.1)** are quick and easy to connect and also provide some major technical and economic advantages when being installed.

With the introduction of European product standards EN 545 [8.1] and EN 598 [8.2] for ductile iron pipes, functional requirements for the joints were laid down for the first time. For reasons of compatibility, all that remained fixed was the diameter of the spigot end.

Fig. 8.1:
Ductile iron sewer pipes
with the TYTON® push-in joint

It is therefore the manufacturer's responsibility to design and produce the joint in such a way that the stringent functional requirements are met.

In EN 545 [8.1] and EN 598 [8.2], the following functional requirements are laid down for movable, non-restrained joints:

- angular deflection (as a function of nominal size, **Table 8.1**),
- axial mobility (declared by manufacturer)
- test conditions for the following pressures:
  1. positive internal hydrostatic pressure
  2. negative internal pressure
  3. positive external hydrostatic pressure
  4. cyclic internal hydrostatic pressure.

The maximum angular deflections for push-in joints can be seen from **Table 8.1.**

Table 8.1:
Angular deflection of the most important push-in joints

<table>
<tr><th rowspan="2">DN</th><th colspan="2">Maximum angular deflection</th></tr>
<tr><th>TYTON®</th><th>STANDARD</th></tr>
<tr><td>80 – 150</td><td rowspan="2">5°</td><td>5°</td></tr>
<tr><td>200 – 300</td><td>4°</td></tr>
<tr><td>350 – 400</td><td>4°</td><td rowspan="2">3°</td></tr>
<tr><td>500 – 600</td><td rowspan="3">3°</td></tr>
<tr><td>700 – 800</td><td>2°</td></tr>
<tr><td>900 – 1000</td><td rowspan="3">1,5°</td></tr>
<tr><td>1200 – 1400</td><td>1,5°</td></tr>
<tr><td>1600 – 2000</td><td>—</td></tr>
<tr><td colspan="3">Note: On a 6 m long pipe, an angular deflection of 3° produces a deflection of about 30 cm off the axis of the pipe or fitting installed previously.</td></tr>
</table>

When type tests are made to ensure that the functional requirements are met, the following binding limiting conditions have to be met **(Table 8.2)**.

Table 8.2:
Limiting conditions for the type tests on push-in joints

1	Joint of maximum annulus
2	Maximum angular deflection
3	Maximum axial withdrawal
4	Mean thickness of pipe wall
5	Aligned position with shear load

The programme of tests provided for restrained movable joints is substantially the same **(Chapter 9)**. Nominal sizes representative of given groupings of nominal sizes **(Table 8.3)** have to be tested in these tests.

Table 8.3:
Groupings of nominal sizes for type tests on push-in joints under EN 545 [8.1]

DN grouping	Preferred DN in each grouping
80 – 250	200
300 – 600	400
700 – 1000	800
1100 – 2000	1600

In Germany, the standard which governs designs of joints which meet the requirements described above is DIN 28603 [8.3]. The dimensions and permitted deviations (tolerances on dimensions) given in this standard are important for ensuring that the functional requirements are met. By specifying these characteristics, DIN 28603 [8.3] becomes one of the significant bases of DVGW Arbeitsblatt GW 337 [8.4], which is the document governing certification.

Under DVGW testing specification DVGW Arbeitsblatt GW 337 [8.4], which is mandatory for ductile iron pipes and fittings in Germany, the tests on the functional fitness for purpose of joints are carried out as externally monitored type tests.
This attestation of conformity is an important part of the **FGR® quality seal** by which the members of EADIPS® (**E**uropean **A**ssociation for **D**uctile **I**ron **P**ipe **S**ystems) provide evidence of the suitability of their products (ductile iron pipes, fittings and valves) with regard to the safety, security, fitness for purpose, quality, hygiene and environmental compatibility required in water supply.
The requirements in these respects which are laid down by standards documents are fundamental to the ability of the ductile iron pipe system to perform properly and they can only be met by ensuring the following:

- The dimensions of the individual parts of the joint have to be properly matched to one another.
- The elastomeric gaskets have to withstand high stresses.

A joint of the present type will remain leak tight even under the highest loading from internal pressure and even when the end of a pipe is mis-aligned and angularly deflected to the maximum in the socket. The test certificates for the type tests which have to be carried out show this to be the case. The high dimensional stability of the sockets is one of the ways in which these characteristics are achieved

What all the push-in joint systems have in common is that they are able to move and act as longitudinally displaceable joints. Hence they do not transmit bending moments or longitudinal forces.

If longitudinal forces have to be transmitted from pipe to pipe or from pipe to fitting/valve, restrained designs of joint have to be used. These are dealt with in detail in **Chapter 9**. The long-term absence of leaks at the joints is ensured by the permanently elastic properties of the gasket itself but also by the match achieved by design between the spigot end of the pipe, the socket and the gasket.
Even when the permitted tolerances produce a worst-case pairing of dimensions at the joint and the spigot end is mis-

aligned to the maximum in the socket, the joint will remain leak tight under all the types of pressure-induced stress which may occur.

Because of their axial mobility and angular deflectability and because of the elasticity of the gaskets used, the joints are able to follow even large movements of the ground, e.g. mining subsidence or earthquakes, and to remain leak tight as they do so. A limit is set to the mis-aligning travel by the structural design, whereby forces due to differences in settlement are transmitted to the spigot end by the centralising collar and the gasket plays only a small part in transmitting the load.

Its sealing function is no more affected by high internal pressures than it is by partial vacuums or by pressures above atmospheric acting on the joint from outside.

For fitting in water and wastewater pipelines and sewers, the quality of the gaskets complies with EN 681-1 [8.5]

More detailed information on the gaskets can be found in **Chapter 13**.

8.2 Types of joint

8.2.1 The TYTON® push-in joint

The push-in joint most widely used in Germany is the TYTON® push-in joint system. There are standards for it over the range from DN 80 to DN 1400. Since it was launched on the German market in 1957, it has proved its worth a million times over in pipelines for drinking water, raw water, wastewater and sewage.

Fig. 8.2 is a cross-section showing the structural design of the joint.

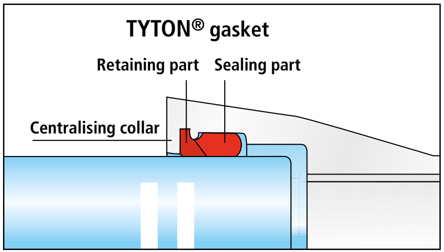

Fig. 8.2:
TYTON® push-in joint system

The significant dimensions of this joint are laid down in DIN 28603 [8.3] for the nominal sizes from DN 80 to DN 1400.

The sealing function in the TYTON® push-in joint is performed by a profiled gasket which consists of a softer rubber mixture (the sealing part) and a harder rubber mixture (the retaining part).

The design of the gasket can also be seen from **Fig. 8.2**. On being fitted into the socket, the gasket is seated in the sealing chamber with a small amount of pre-compression, i.e. the outside diameter of its softer sealing part is larger than the inside diameter of the sealing chamber in the socket. The result of this is that, at the sealing bead which it forms, about 30 % of the gasket projects into the cross-sectional area into which the spigot end of the pipe is going to be pushed. The suitably matched diameters of the sealing chamber, the sealing bead and the pipe cause the gasket to be highly deformed and hence a high pressure to be applied to the sealing surfaces.

If the spigot end of the pipe is mis-aligned, the gasket cannot be compressed to an excessive degree by an external load on the pipe because a structural limit is set for the mis-aligning travel firstly by the centralising collar and secondly by the limiter in the sealing chamber. Behaviour is similar when there are movements producing angular deflections, for which structural limits are likewise set.

The harder annular part of the gasket (the retaining part) is moulded to a claw-like shape and engages in the retaining groove in the socket. It holds the gasket firmly in position when the end of the pipe is pushed in and also later when a load is applied by the internal pressure.
Under a load applied by internal pressure, the retaining part is supported against the centralising collar and, by being so supported, closes off the gap between the centralising collar and the pipe. It thus prevents the gasket from being forced out even at very high internal pressures. The joint remains sealed even up to the bursting pressure of the pipe system.

The bead-like sealing part composed of softer rubber is compressed when the spigot end is pushed in in such a way that a reliable seal is obtained.

8.2.2 The STANDARD push-in joint

The structural design and the operation of the STANDARD push-in joint are comparable to those of the TYTON® push-in joint. In Germany, the dimensions of the joint are laid down in DIN 28603 [8.3] (Form C) for nominal sizes from DN 80 to DN 2000.

A schematic view of the joint is shown in **Fig. 8.3**.

The gasket consists of rubber of a single hardness.

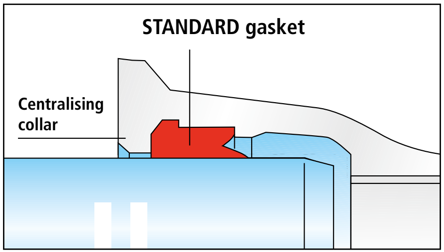

Fig. 8.3:
STANDARD push-in joint system

The maximum angular deflections for the TYTON® and STANDARD push-in joints can be seen from **Table 8.1**.

8.3 Fields of use

The purpose of joints between pipes is to help to provide a supply of satisfactory drinking water, to help to ensure that wastewater and sewage are safely disposed of and to help to protect bodies and watercourses of surface and underground water. Other fields of use for ductile iron pipes with push-in joints are in the transportation of raw water and process water and they are also used in irrigation and in systems for fire-fighting and snow-making – although it is mainly in a restrained form in which they are used in these latter cases **(Chapter 9)**.

In the case of pressure pipes of ductile iron, the TYTON® system and STANDARD system push-in joints are used in water pipelines to EN 545 [8.1] and in sewers and pipelines for sewage and wastewater to EN 598 [8.2].

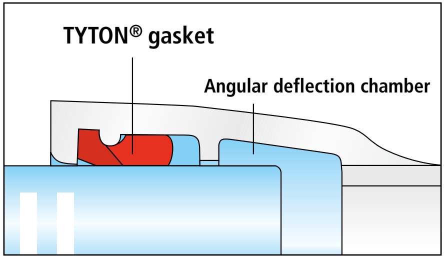

Fig. 8.4:
TYTON® long socket

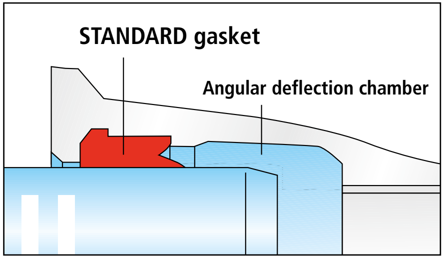

Fig. 8.5:
STANDARD long socket

Ductile iron fittings with the TYTON® or STANDARD push-in joint system are also covered by the above standards.

Ductile iron pipes and fittings with push-in joints are used in pressure pipelines as a function of the diameter of the pipes and the wall-thickness classes for allowable operating pressures as given in the above product standards and also in the manufacturers' catalogues.

For pipelines installed in unstable ground or in areas subject to mining subsidence, the TYTON® and STANDARD push-in joints are produced with a long socket (DIN 28603 [8.3], form B) which allows longer axial displacements than the usual form A socket **(Figs. 8.4 and 8.5)**.

As a percentage of the laying length of the pipe, axial displaceability increases to 0.8 % in the nominal size range from DN 700 to DN 1000. A marking line which can still be seen outside the socket shows the neutral position of the joint. If it is known exactly what axial movements can be expected, the spigot end can be inserted as far as the beginning or end, as the case may be, of the angular deflection chamber.

Pipes and fittings for ductile iron sewers and wastewater pipelines are designed for the operating pressures given in Table 5 of EN 598 [8.2]. A wide variety of stresses result from joints being used in, for example, gravity pipelines, pressure pipelines for sewage and wastewater, pressure pipelines for sludge and pipelines for leakage water. The joints have to withstand these stresses and to remain leak tight for decades.

This is also particularly true where pipelines are positioned in groundwater and when they are installed with large heights of cover.

A requirement which is particularly difficult to meet for push-in joints used in sewage and wastewater pipelines is resistance to root intrusion.
Extensive investigations carried out all over the world have shown that tree roots are able to penetrate into push-in joints sealed by rubber if the compression of the gasket is not high enough to resist the pressure exerted by the tip of the root. This is the case with lip seals for example. Because of the high tensile strength of ductile iron, it was possible

for the compression of the TYTON® and STANDARD gaskets to be selected, by design, to be so high that it can be relied upon that roots will not grow into the joint.
Root intrusion has in fact never been found in sewage or wastewater pipelines with properly assembled TYTON® push-in joints [8.6].

8.4 References

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