

# Waterstops

Trelleborg Ridderkerk BV



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Photo: Thomassen tunnel

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This brochure is composed by Trelleborg Ridderkerk BV, if more information is needed please consult our sales or technical department at Ridderkerk (The Netherlands).

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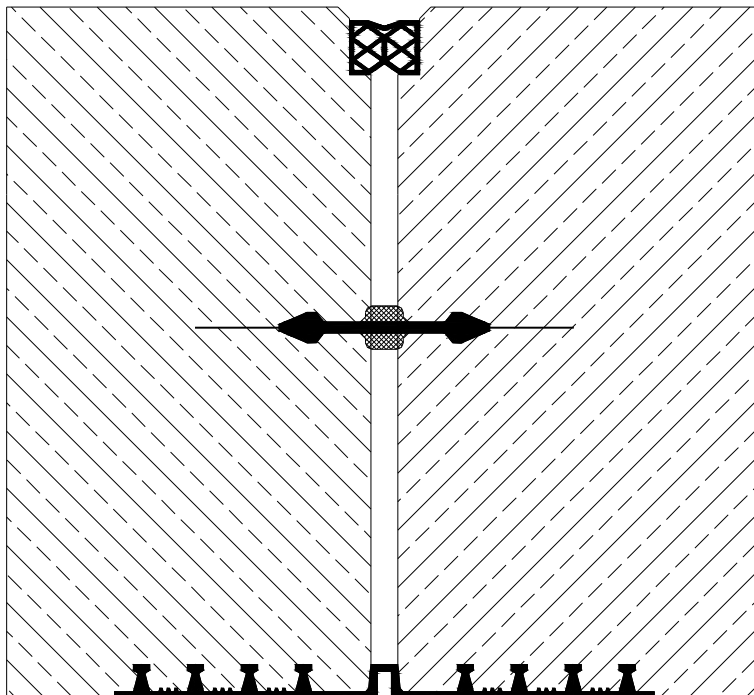
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## Introduction

The Dutch have always had to struggle with the sea to "keep their feet dry". Special construction methods have been developed to solve various problems in ensuring a structure is watertight.

Sealing problems occur especially where concrete structures are too large to be poured as one monolithic unit. Ensuring joint water tightness is therefore of paramount concern particularly for underwater and immersed structures such as tunnels under rivers and canals, basement garages and cellars, dry docks, locks, etc.

For these applications special joint sealing systems have been developed to ensure watertight joints.



## Use of waterstop

Many large concrete structures are too big to be poured as one monolithic unit and therefore have a number of constructions joints.

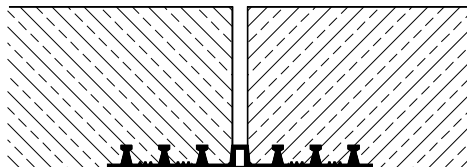
Two different types of joints can be identified:

- The work-joint which has to be watertight without having to accommodate movement between the adjacent concrete pours.
- The expansion joint which has to accommodate water pressure as well as the possible movement between the individually poured concrete sections.

In a joint three types of waterstops can be utilized.

### External waterstop

The external waterstop is mounted on the wet side of a concrete structure. This type of waterstop protects the joint against ingress of mud or any other substance. This waterstop is also installed in structures where a “double tightness” system is desired, e.g. nuclear power plants or at ramps to motorway tunnels. This type of waterstop is only recommended in open structures such as tunnel roofs where air can be trapped within the joint.



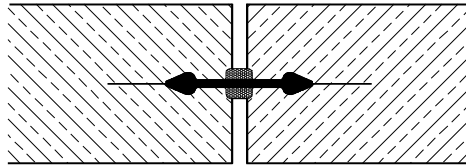
### Internal waterstop

The primary seal between two concrete structures is accomplished by the internal waterstop. This waterstop is always fitted roughly in the centre of the wall and bridges the expansion/movement joint in the wall. When this type of waterstop is used to seal an expansion joint, the waterstop has a central sponge at its centre. The purpose of this central section is to form a free space in the concrete, which is necessary to allow movement. The central sponge may be formed with hard rubber with a central hole or with two rectangular strips of sponge rubber at the centre, one on each side.

The sponge rubber strips, being flexible, facilitate the fixing of the waterstop into the shuttering and create at the same time a perfect seal between the sponge rubber and the shuttering. During the concrete pouring and casting process no cement slurry is able to drain off owing to shutter leakage thereby preventing honeycombing and the formation of cavities in the concrete.

The concrete quality in the area around the waterstop is critical in ensuring water-tightness.

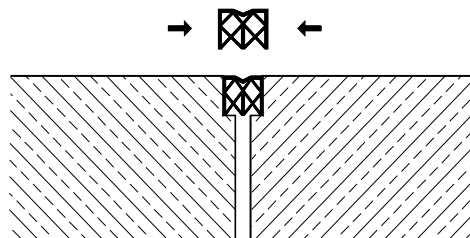
The sponge rubber is available in different sizes, dependent on the joint width during pouring.



### Expansion joint

The expansion joint is installed once the concrete structure has hardened. It's function is to keep the joint clean and open to prevent ingress of dust and dirt which could lead to disfunction of the joint. The expansion joint needs special dimensions to ensure that it fits the joint and accommodates the joint expansion.

For detailed information about this waterstop refer to our brochure 'Expansion Joints'.



## Construction of waterstops

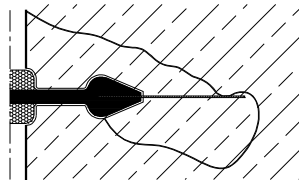
Waterstops are produced in different types. The waterstop type depends on the water pressure and desired water tightness of the joint

In structures with low water pressure a solid rubber waterstop may be used.

### Rubber waterstop with vulcanised steel strips

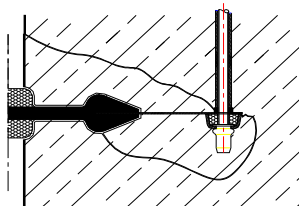
When water pressures are higher and no leakage is permitted, waterstops with steel strips vulcanized into the end bulbs of the rubber waterstop are used. Concrete does not adhere to rubber or PVC, but makes a good bond with the steel strip, providing the desired water tightness.

The steel strip also increases the path of leakage which decreases leakage problems



### Injection waterstop

The waterstop with vulcanised steel strip will give absolute water tightness between the concrete and the steel strips.





However, in practice, fissures and gravel spots are caused by shrinkage in the concrete and by errors during the pouring process. The concrete in the direct vicinity of the waterstop may therefore show seepage even though the waterstop is providing the required watertightness. In practice around 10% of all joints may have this leakage through the concrete.

To eliminate this leakage, Trelleborg Ridderkerk has developed a waterstop system that allows direct injection of epoxy resin or similar into the concrete around the edges of the waterstop. For further details regarding this waterstop we refer to our special brochure 'Injection Waterstop W9U-I'.

### Summary of standard waterstops

A summary of Trelleborg Ridderkerk standard waterstops is given in the Table below. In Appendix 1,2 and 3 you will find technical drawings of the waterstops.

Table 1: Standard Waterstops

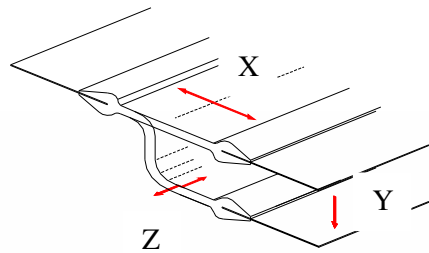
Type	Waterstoptype	Product description	Application
W2L	External/internal	Rubber	Clamping
W2LS	External/internal	Rubber-steel	Clamping
W5B	External	Rubber	Clamping
W10U-250	Internal	Rubber-steel	Internal joints
W9U	Internal	Rubber-steel	Internal joints
W9CU	Internal	Rubber-steel	Internal joints
W9U-i	Internal	Rubber-steel + injection	Internal joints
W9CU-i	Internal	Rubber-steel + injection	Internal joints

On request we can supply other types as well



### Application Design Data

The final choice of waterstop is governed by the desired structural movement and water pressure. Both cause a tension in the rubber. In Appendix 4; graphical design data is provided for a range of waterstops. The design graphs indicate the maximum waterstop movements in the X, Y, and Z directions at a certain water pressure (in meters of water column).



## Rubber quality

The *standard* material for the manufacture of waterstops is Styrene Butadiene Rubber (SBR).

If the SBR rubber quality' is not suitable for the proposed application other rubber compounds are available. Alternative rubber compounds available are Ethylene propylene diene monomer (EPDM), Chloroprene rubber (CR), Natural rubber (NR) or Nitrile rubber (NBR)

In view of the long service life required and the fact that waterstops cannot be replaced, the rubber material has to be of a very high quality. Repair of leaking joints post the pouring of a structure using epoxy injection repair systems or similar is a costly operation so the correct choice of the rubber quality is of paramount importance. The optimal physical properties of the various alternative rubber compounds depends on the type of rubber elastomer used.

### Mechanical Properties

All standard waterstops are certified through our own laboratory and will be delivered in accordance with the Dutch NEN 7030 standard. We can also supply waterstops according to German DIN 7865 standard. On request quality-test- certificates can be shown. The table below shows the NEN 7030 standard.

Table 2: Standard NEN 7030 Physical Property Requirements

Polymer	SBR
Hardness (°Shore A)	60 ± 5
Tensile strength (N/mm <sup>2</sup> )	≥ 17,1
Elongation at break (%)	≥ 375
Tear resistance (N)	≥ 31,1
Change after 14 days / 70 °C	
Tensile strength (%)	≤ 25
Elongation at break (%)	≤ 30
Hardness (° Shore A)	≤ 8
Compression set 72 hrs 23°C (%)	≤ 10
Water absorption (gr/m <sup>2</sup> )	≤ 30
Ozone resistance 120 hrs/25 pphm/20°C/20% tear	No cracks
Low temperature resistance	
Change of hardness at 0 °C (°Shore A)	≤ 5
Change of hardness at -10 °C (°Shore A)	≤ 8

### Chemical resistance

The table below summarizes the resistance and performance of various rubber compounds to a range of common chemicals. This table provides an indication of a suitable elastomer. The data is based on a temperature of 20 °C and concentrated solutions. For confirmation of a correct selection please don't hesitate to contact us.

Table 3: Chemical resistance

Quality	SBR	EPDM	CR	NR	NBR
Natural gas	Moderate	Moderate	Excellent	Moderate	Excellent
Petroleum	Not	Not	Moderate	Not	Excellent
Liquefied Ammonia	Excellent	Excellent	Excellent	Excellent	Excellent
ASTM Oil No. 1	Moderate	Not	Excellent	Not	Excellent
ASTM Oil No. 2	Not	Not	Good	Not	Excellent
ASTM Oil No. 3	Not	Not	Good	Not	Good
Petrol	Not	Not	Good	Not	Excellent
Brackish Water	Excellent	Excellent	Excellent	Excellent	Excellent
Diesel	Not	Not	Good	Not	Excellent
Kerosene	Not	Not	Not	Not	Excellent
Air from .. till .. °Celsius	-15 till 70	-20 till 110	-10 till 90	-40 till 70	-20 till 70
Mineral Oil	Not	Not	Good	Not	Excellent
Motor Oil	Not	Not	Excellent	Not	Excellent
Water till .. °Celsius	70	110	70	70	70
Weather conditions/Ozone	Moderate	Excellent	Excellent	Moderate	Moderate
Seawater	Moderate	Excellent	Excellent	Moderate	Excellent
Sulphured Hydrogen	Not	Good	Moderate	Not	Good

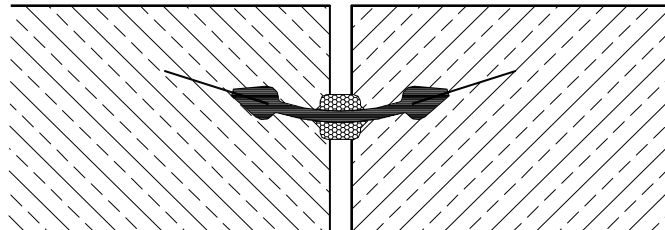
## Mounting procedure

The water tightness of the joint is often determined by the way a waterstop is installed. The waterstop is most vulnerable whilst mounting. The internal waterstop supplied with vulcanised steel strips has holes in the strips for installation purposes.

It is important to ensure that the centre of the waterstop is placed in the center of the movement/expansion joint and that the waterstop doesn't move in relation to the joint while the concrete is poured. Waterstop movement is a particular problem when there are high concrete pressures during the concrete pour.

The concrete underneath the waterstop has to be vibrated and consolidated during the pour otherwise porosity, cavities and honey combing will occur.

When the waterstop is mounted horizontally the ends should rise upward, in order to prevent air entrapment. The number of longitudinal ridges should also be minimised to reduce the possibility of trapping air under the waterstop.



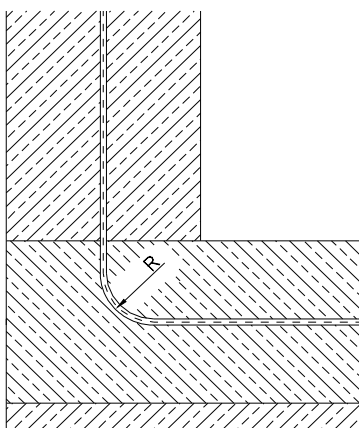
Once the waterstop has the concrete poured on one side, the other side needs to be cleaned to ensure it is free of sharp objects.

## Corners/special constructions

Trelleborg Ridderkerk can supply prefabricated flat or standing corners for every desired angle. Improved joint strength and security can be achieved as factory joints can be hot vulcanised to maximized joint strength.

Any joints required to be made on site should always be made in a length of straight waterstop. A joint requires a minimum straight length of 20 cm on each side of the joint. It is recommended, where possible, to make all corners in the factory. The design of the corners and location of site joints should be resolved in consultation with the consultant and Trelleborg Ridderkerk. Site joints can be vulcanised at the construction site by Trelleborg Ridderkerk engineers. It is possible to mount internal waterstops with a radius. The minimum radius for various waterstops are shown in the following table.

Table: 4 Radius



Waterstop	Radii (mm)
W10U-250	> 100
W9U	> 100
W9U-I	> 100
W9CU	> 150
W9CU-I	> 150

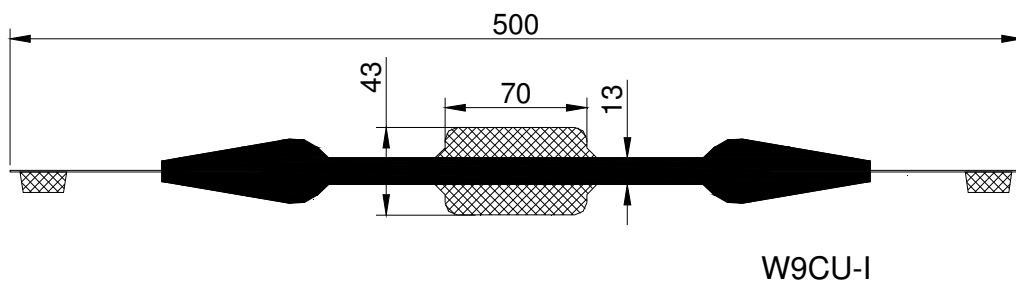
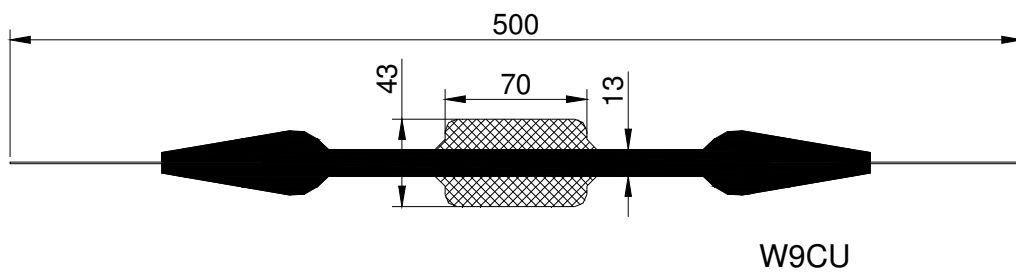
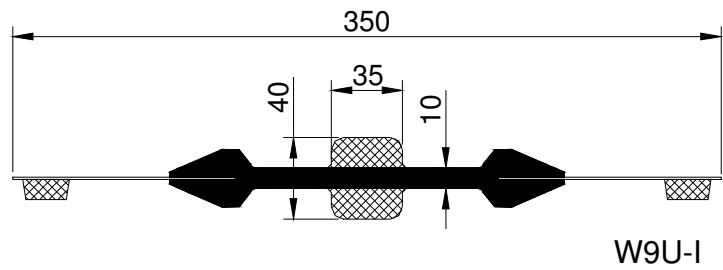
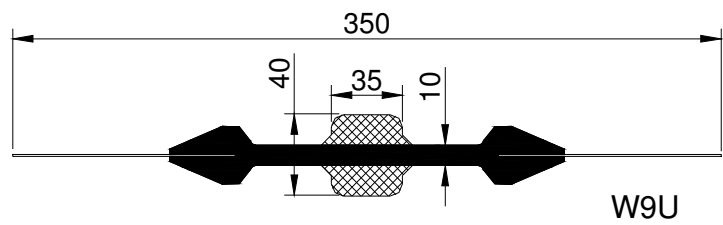
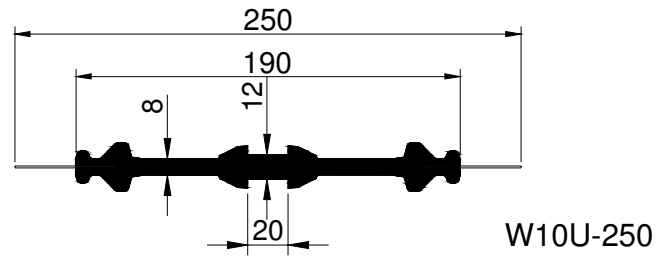
Appendix 5 details all the possible styles of corners and their names.

Trelleborg Ridderkerk also has various solutions for:

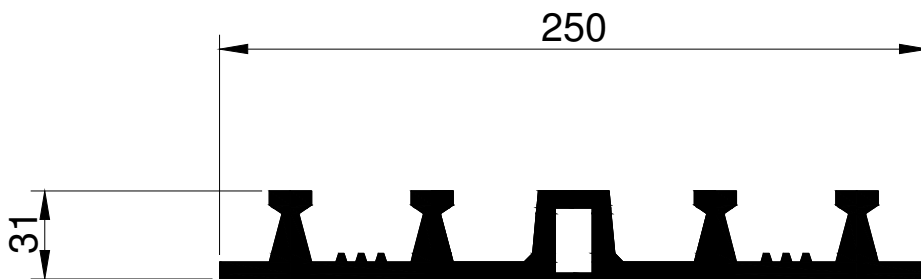
- connections between different types of waterstops
- connections between waterstop and sheet piling
- vulcanised steel endstrip

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*Appendix 1. Internal waterstops*



*Appendix 2. External waterstops*



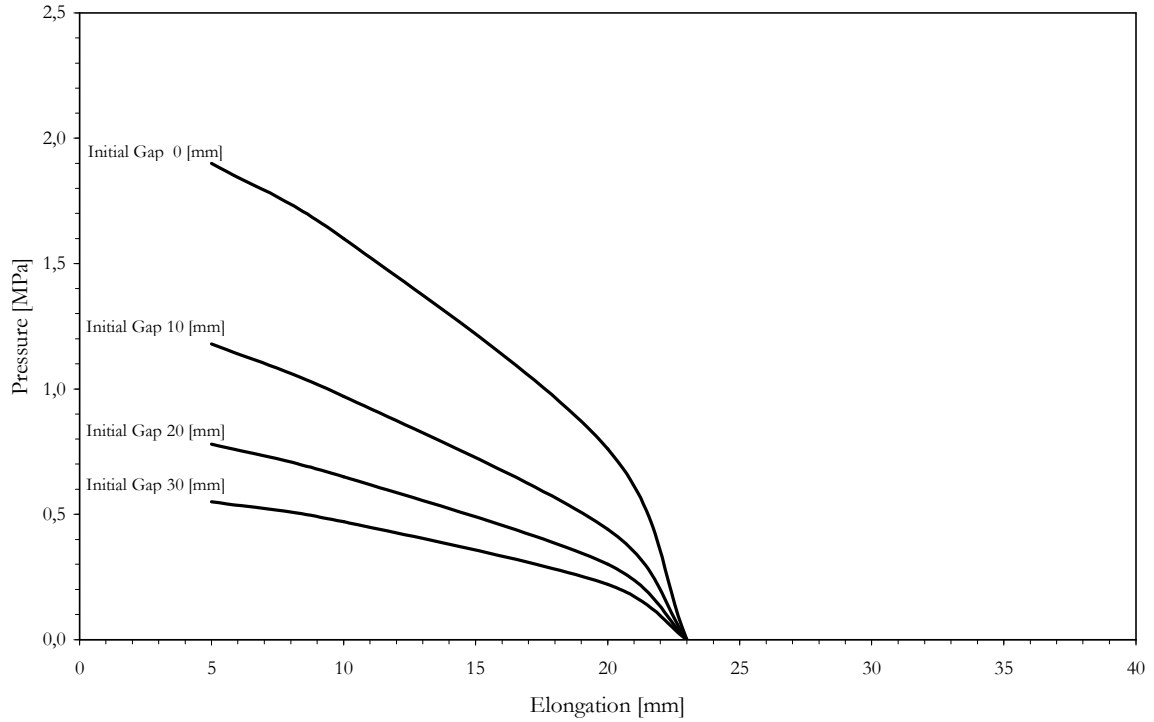
AM 250



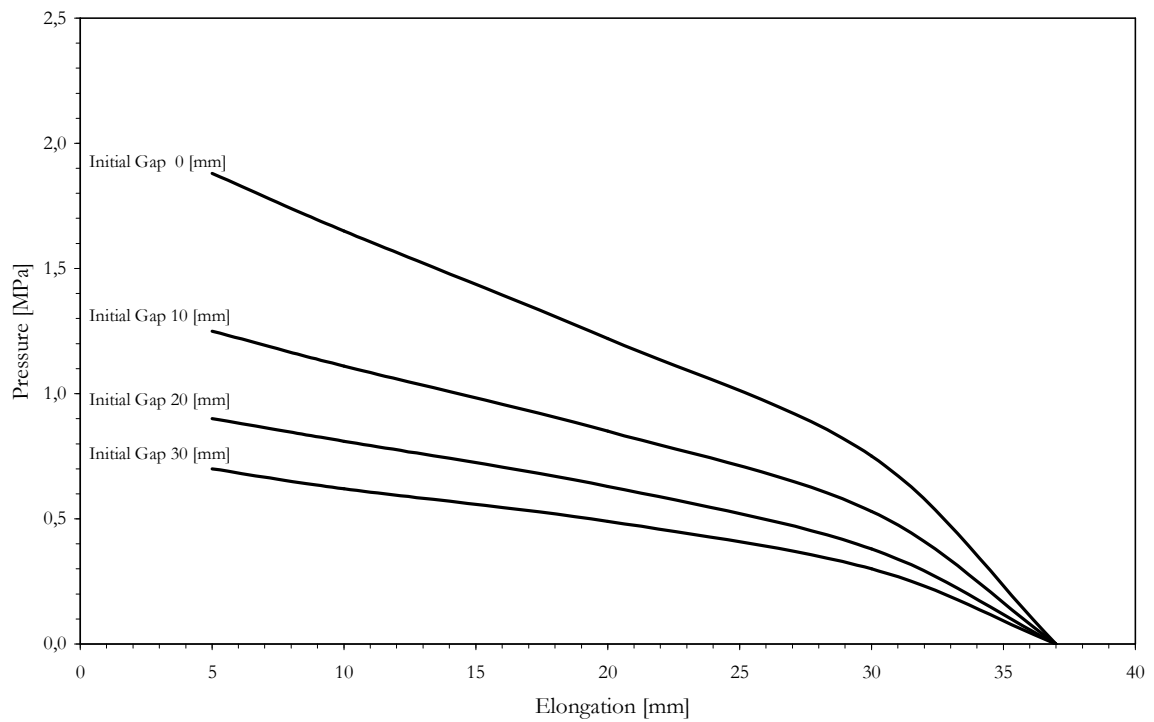
AM 350

Appendix 3. Application Design Data - Waterstops

Application data W9U & W9Ui  
SLS conditions



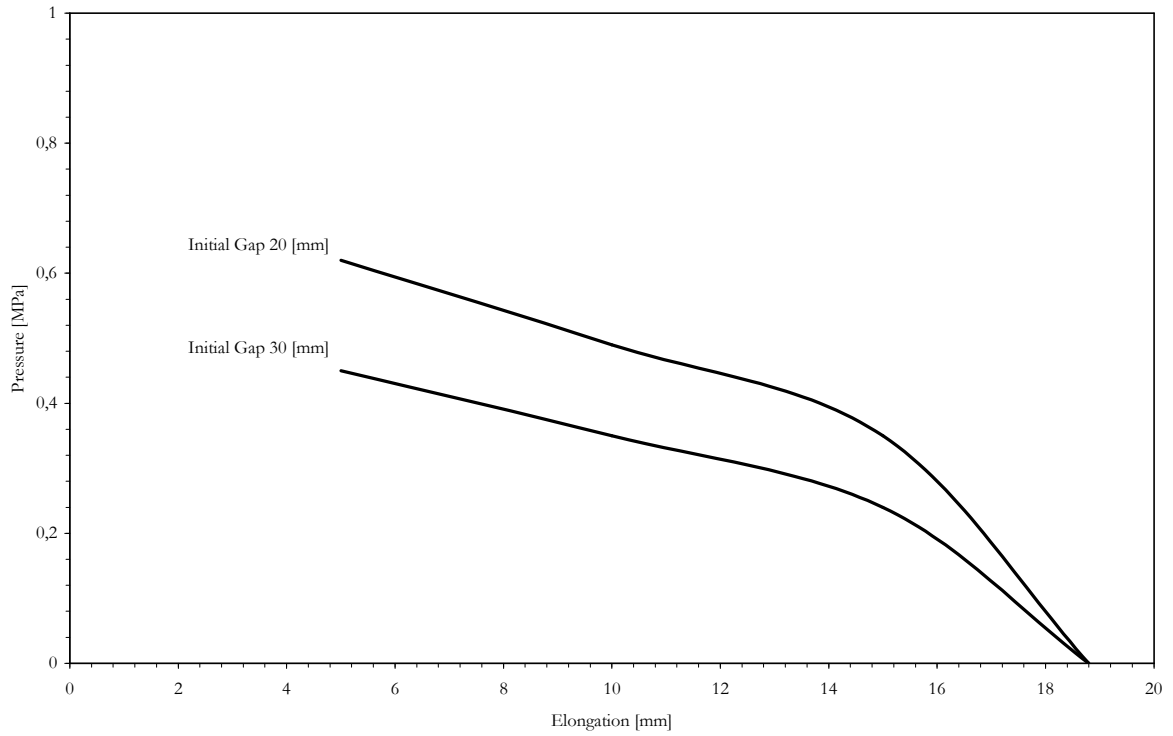
Application data W9CU & W9CUi  
SLS conditions



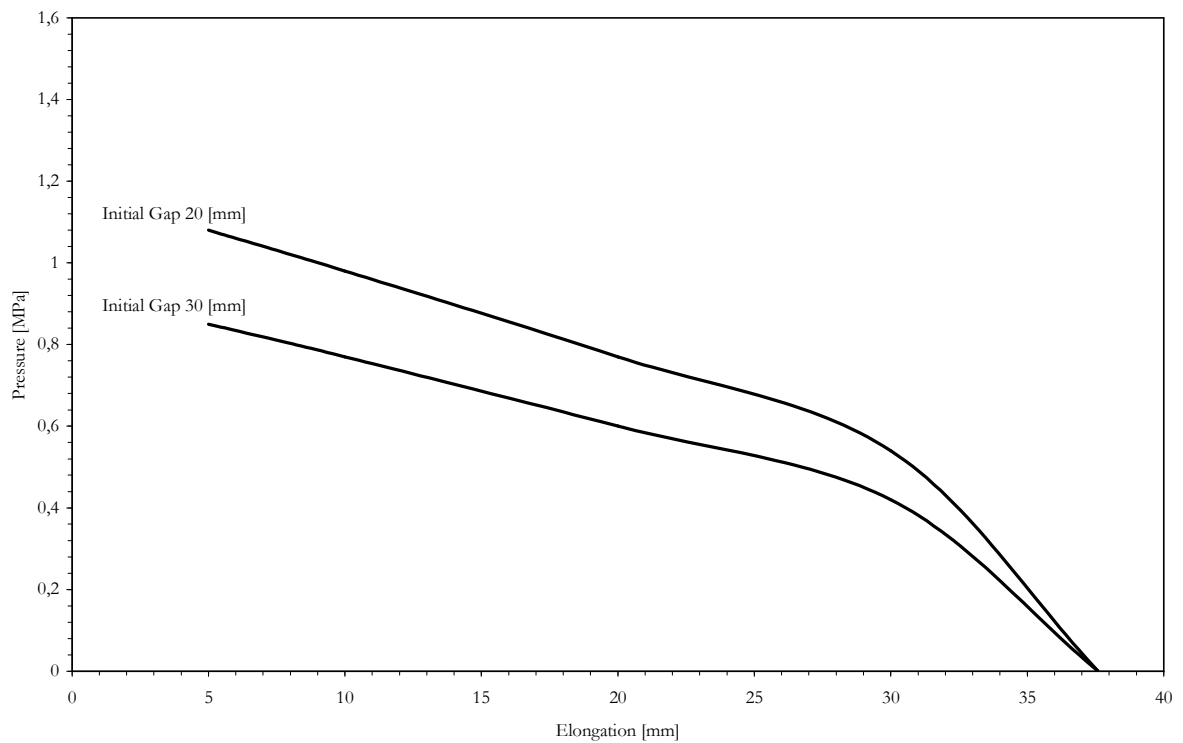


Application Design Data – Waterstops

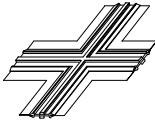


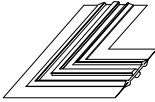
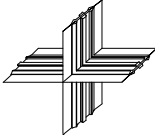
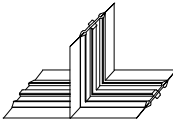
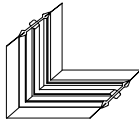
Application Data W10U  
SLS conditions



Application Data W10U  
ULS conditions



*Appendix 5. Corner constructions*

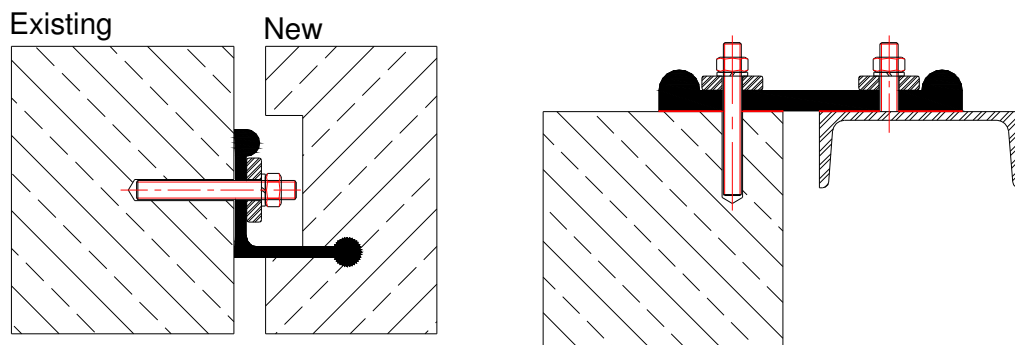
	<p>Flat cross</p>
	<p>Flat T joint</p>
	<p>Straight joint</p>
	<p>Flat corner joint</p>
	<p>Standing cross</p>
	<p>Standing T joint</p>
	<p>Standing corner joint</p>

## Clamping joints

### Introduction

In new constructions waterstops are poured halfway in the concrete. When a watertight sealing is desired between two existing structures or between an existing and a new structure, a different type of waterstop is needed.

Trelleborg has a number of different waterstops (or clamping joints) in its program for this purpose. The choice for one of these waterstops depends on the circumstances such as permissible movement, water pressure and type of construction.

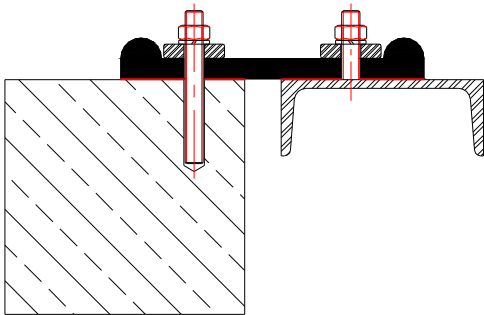


## Area of application

The clamping joints can be applied when a watertight sealing is desired between two existing structures or between an existing and a new structure.

### Two existing structures

#### Flat surface

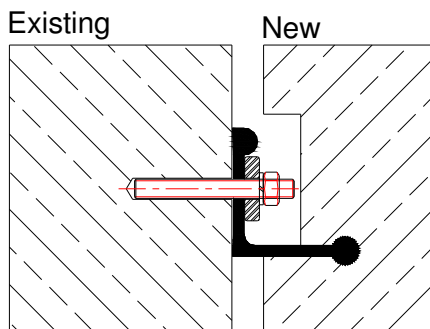


For sealing a flat joint the W5B can be applied.

#### Corner surface

For sealing a corner joint the W5L can be applied.

### Existing and a new structures



For sealing this joint the W2L can be applied.

The choice for a specific type of waterstop depends on water pressure, type of structures, clamping system and movement. For a definite choice of clamping system please contact our office.

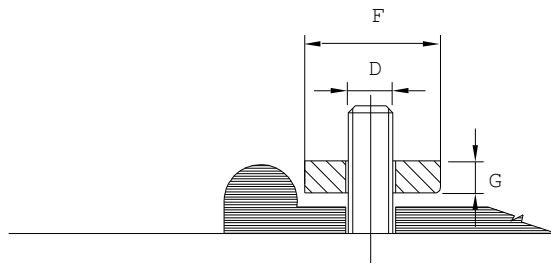
## Clamping/pressure strips

The clamping joints are mounted to the existing structures with clamping or pressure strips.

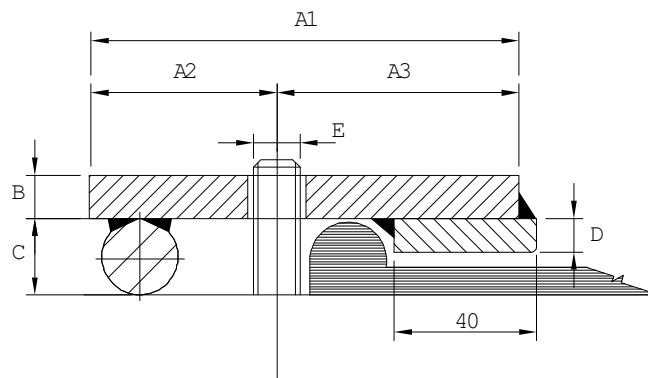
These strips are attached to the wall with bolts and anchors, for the choice of the right fasteners we advice to consult the supplier.

In relation to the clamping device, there are two types.

### Pressure strips



### Clamping strips



The choice for a specific type of clamping device depends on water pressure, type of waterstop and movement. In general the clamping strip is better for more heavy conditions. This because no holes in the waterstop are needed and the anchors have a bigger distance to the concrete edge.

For the correct choice of clamp, please contact our office.

## Plastic mass / S40

As a result of a rough surface leakage can appear between the concrete or steel surface and the rubber waterstop.

To prevent this a flexible material is put between the concrete or steel surface and the waterstop. We recommend S40 (rubber-concrete kit) or plastic mass (unvulcanised strip off rubber). By filling all small gaps and holes a perfect sealing is accomplished.

## Mounting procedure

### Preparation

Before mounting the clamping joint following preparations must be made.

- attach fasteners (bolts/anchors) onto the existing wall (according to supplier's instructions );
- check the bolt length;
- check if the clamping strips fit (including corner strips);
- check if the bolts and nuts fit properly;
- clean the mounting surface;
- when using clamping strips mark the bolt positions and make holes with a hollow drill;
- when using plastic mass, attach it with solution to the clamping surface of the waterstop.

### Mounting procedure

- apply waterstop;
- mounting corner strips;
- mounting other strips from corner to the centre;
- tighten nuts with the correct torque;
- tighten nuts again next day with the right torque because of relaxation rubber.

### Note

In some cases it is better to adjust the waterstop on the construction site because of narrow tolerances. These specialised activities can be done by a Trelleborg engineer.

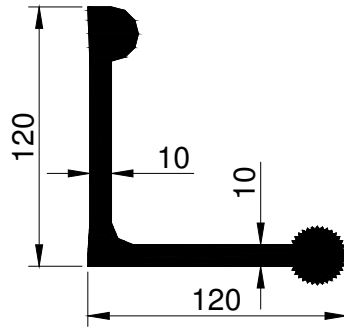


## **Corners**

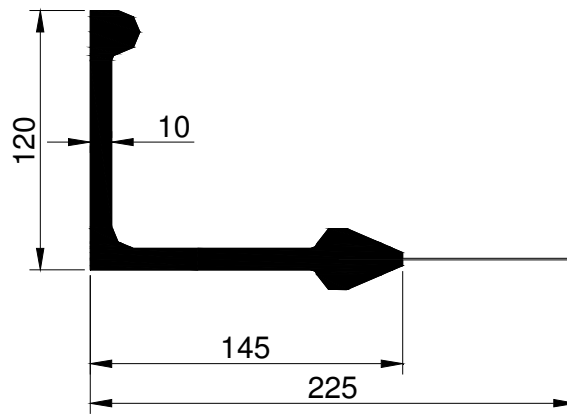
Trelleborg can supply prefab-corners for the waterstops in every angle desired as well flat corners or standing corners. A 100% bonding is guaranteed because all constructions are hot-vulcanised in our factory.

A connection between two constructions is always made in straight lengths. The minimum length to make a connection is 20 cm on each side. It is recommended to make connections in the factory. The composition of the construction depends on the type of work and can be established in consultation with Trelleborg. The additional straight connections can be vulcanised on the construction site by Trelleborg engineers.

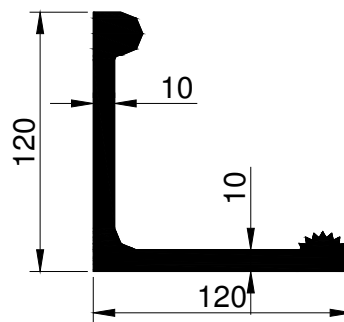
Appendix 1. Product drawing



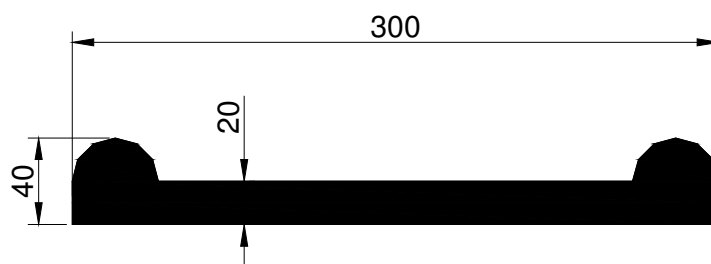
W2L



W2LS



W5L



W5B







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