



**New diaphragm
wall joint system
allowing greater
depths and high
quality joints**

TTMJ

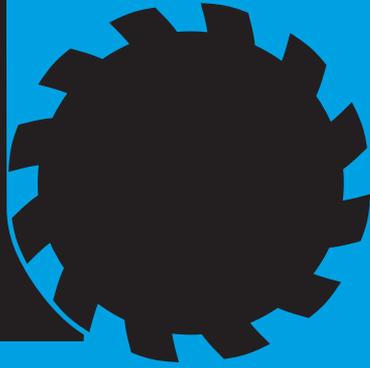
**Tension
Track
Milled
Joint**



**This project has received funding from
the European Union's Horizon 2020
research and innovation programme
under grant agreement No. 720579**



Why TTMJ ?

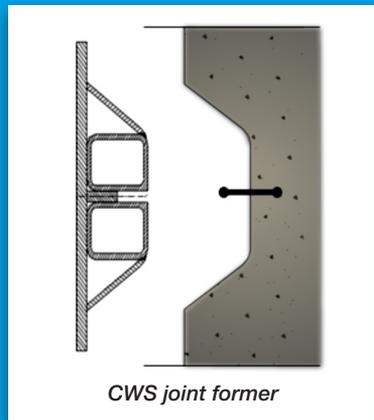


Diaphragm Wall / Slurry Wall technology has developed significantly over the last 50 years or so. At the same time the average depth of the Walls has increased steadily. During this time, the initial rounded clam shell grabs have been replaced by square ended clamshell grabs. This led to development of the “peel off” continuous water stop (CWS) - a highly successful and efficient method for forming well-defined joints

These CWS joints worked very successfully in the standard 20 m - 40 m deep walls for which they were designed. Increasing Wall depths led to a further option (*particularly used for the construction of circular shafts and dam cut off walls*): reverse-circulation “hydro-mills” to form joints by cutting into the concrete of the adjacent panels.

These mills are now routinely used to install walls to depths between 50m, and 100m.

Trevi has recently excavated a test panel to a depth of 250m!



CWS joint former

However, a joint formed by over-cutting the concrete with the mill cannot accommodate a water stop and the shear connection between the panels is limited.



Grab rotator

The **Grab Rotator**, a more recent development, has allowed accurate wall excavation by grab to 60m - 80 m. In finer soils - where excavation by grab has significant advantage to the mill - **using a grab brings very substantial cost savings.**

The CWS Joint is simply not designed to be used to these depths.

The **TTMJ Process** allows Wall excavation to these increased depths, without compromising the quality of the joint between adjacent panels.

Crucially, the trimming of the secondary panel is controlled by the position of the guides in the primary panels of the primary panel. With suitable care the joint can be formed to depth without risk to tolerance.

If the TTMJ system is used with a hydro-mill there is theoretically no limit to the depth that can be achieved.

How Does TTMJ work ?

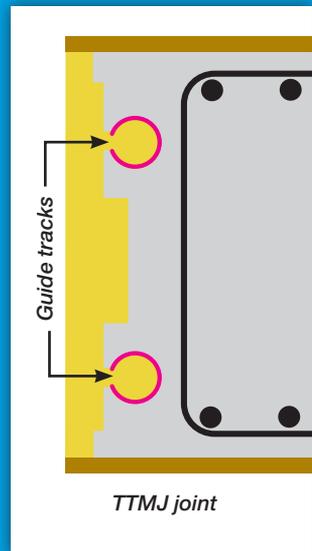
The key to this successful innovation is to combine a straightforward system - **the guide tracks** - with a standard piece of equipment - **the trimmer** - to deliver a significant step forward - **the TTMJ System**.

Guide tracks (shown dark red) are cast in to the primary panel concrete (shown grey above) to the required depth.

When the primary panel concrete has attained sufficient strength ($\sim 20\text{MPa}$), the secondary panel (to the left of the primary panel shown above) can be excavated to full depth. **The TTMJ trimmer** can then be run down the joint, removing the sacrificial section of guide track, and cutting a profile (shown in pink) which can include a shear key (as shown).

The guide tracks are designed (and tested) to avoid distortion and with-stand the forces trying to push the trimmer guides away from the centre line of the joint.

With the joint profiled to required depth, concrete cuttings are removed from the joint and the secondary panel can be concreted.



This is the basic system - time to get rid of your scrap joint-former steel currently lying in the yard!

Benefits

In particular, this new system is designed to:

- Increase the effective depth range of Walls (especially walls excavated by grab) and Secant Walls
- Remove the requirement for Stop-ends or Joint Formers
- Allow for a Shear Key at the joint
- Allow for a Water Stop to be installed at the joint
- Permit Continuous Reinforcement across the joint
- Optimise Reinforcement Density and hence Concrete Flow
- Facilitate joints in corner panels eliminating the need for "L" shaped cages and reducing large single-pour concrete volumes and slurry storage capacity requirements.
- Enable the construction of smaller-dimensioned square and circular deep shafts (especially useful for city-centre sites) than is possible with current methods.

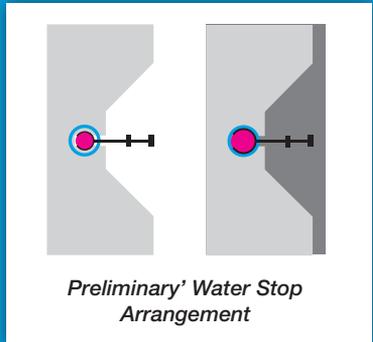
In addition to the technical innovations, the TTMJ system brings a clear cost benefit which can be demonstrated for many projects.

Options / Special developments

The basic system has been designed deliberately to avoid complication due to other options; however, if these are required, they can be easily added:

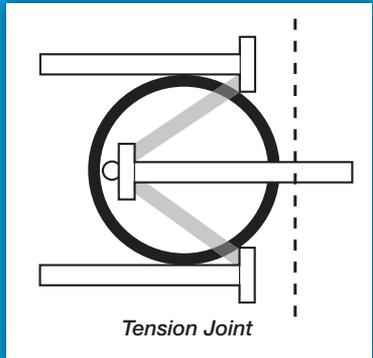
Water Stops / Bars

Development of the water stop/ bar is currently in progress. The preliminary proposal is shown here.



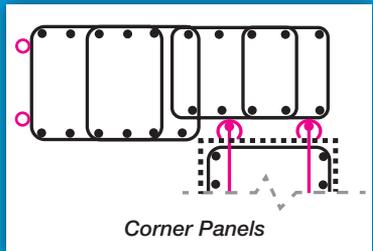
Tension Joints

The ability to deliver real tensile capacity across retaining wall joints with relative ease has been a desired outcome since D Walls were invented. The TTMJ System makes this possible, using the guide tracks' inherent strength.



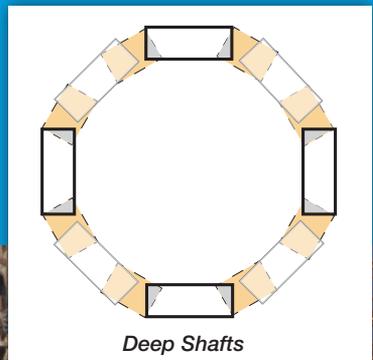
Corner Panels

The TTMJ System allows further flexibility – with the joint acting between the end of a primary panel and the face of the secondary panel. Large volume corner panels are no longer necessary, and tensile capacity can be provided.



Deep Shafts

TTMJ system provides particularly appealing option for deep shafts. In city-centre locations with limited working space, this can provide a realistic solution to allow shaft construction.



Secant Walls

The TTMJ System will be further extended for use with Secant Walls.

This picture shows how little free space is typically available in a city-centre worksite when using an hydro-mill

First Street Tunnel Project - Washington D.C.



TTMJ - Tension Track Milled Joint is an EU-funded project under the framework of Horizon 2020.

The aim of the TTMJ project is to develop, validate and commercialize a new joint system that will provide foundation specialists with the capability to deliver high quality, watertight and safe diaphragm wall joints at lower costs.

The new system, invented and patented by the consortium partner CCMJ System Ltd., offers the possibility to construct profiled joints to increased depth, by maintaining the vertical alignment of the primary panel with a mill or Trimmer that is guided by tracks previously cast into the primary panel (after the secondary panel has been excavated and before it is concreted) ensuring the quality of the joints in the completed diaphragm wall.

**The TTMJ system
offers the possibility
to construct “perfect”
joints to greater
depth**

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TTMJ consortium

The TTMJ Project Consortium comprises:

TREVI Spa

with its considerable experience and know-how in deep foundations, leads the team, coordinate development, build the prototype Trimmer, and trial it in a full-scale field test.

CCMJ Systems

is assisting in the development and continue to provide innovation to the process, with specific responsibility to complete design of the guide track systems.

ARUP bv

is the leading specifier of Diaphragm Walling projects worldwide and is providing engineering input and will be responsible for formal validation of the system.

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