

CROSS BUSINESS LINE

# TechSpan® Precast Arches

F U N I C U L A R   S H A P E   S E R I E S

OCTOBER 2018



**REINFORCED EARTH**



**TERRE ARMEE**



**TIERRA ARMADA**







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## OUR GROUP

**We have been designing and supplying innovative geotechnical engineered structures and reinforced backfill solutions for more than half a century. With more than 100,000 structures completed around the world, our group sets the standard.**

### OUR VISION

Reinforced Earth rolls out its leading technologies to serve clients' projects, from the simplest to the most complex. Guided by our focus on innovation and our culture of excellence in client care, we offer suitable, durable solutions. We build on our global expertise, which is executed by our local companies, to develop new applications and to address the challenges of the future.

### OUR BUSINESS LINES

Our technical solutions are defined by three functions corresponding to the application of the structure to be designed:  
**RETAIN, CROSS, PROTECT.**

### CROSSING STRUCTURES

To cross natural obstacles such as watercourses and valleys, or roads and railways, Reinforced Earth designs both overhead and underground crossing solutions. Our techniques are used to build all types of structures to meet the CROSS function, such as Reinforced Earth® bridge abutments for overhead crossings, as well as cut-and-cover TechSpan® tunnels, culverts and underpasses for below-grade crossings.



## TECHSPAN® ARCHES OVERVIEW

**TechSpan® is a buried precast concrete arch. It generally consists of half arch units that meet at the crown, supported by a footing sized for site specific conditions. The backfill around the arch contributes to the resistance of the entire structure, constraining lateral deflections of the arch under vertical loads (soil-structure interaction).**

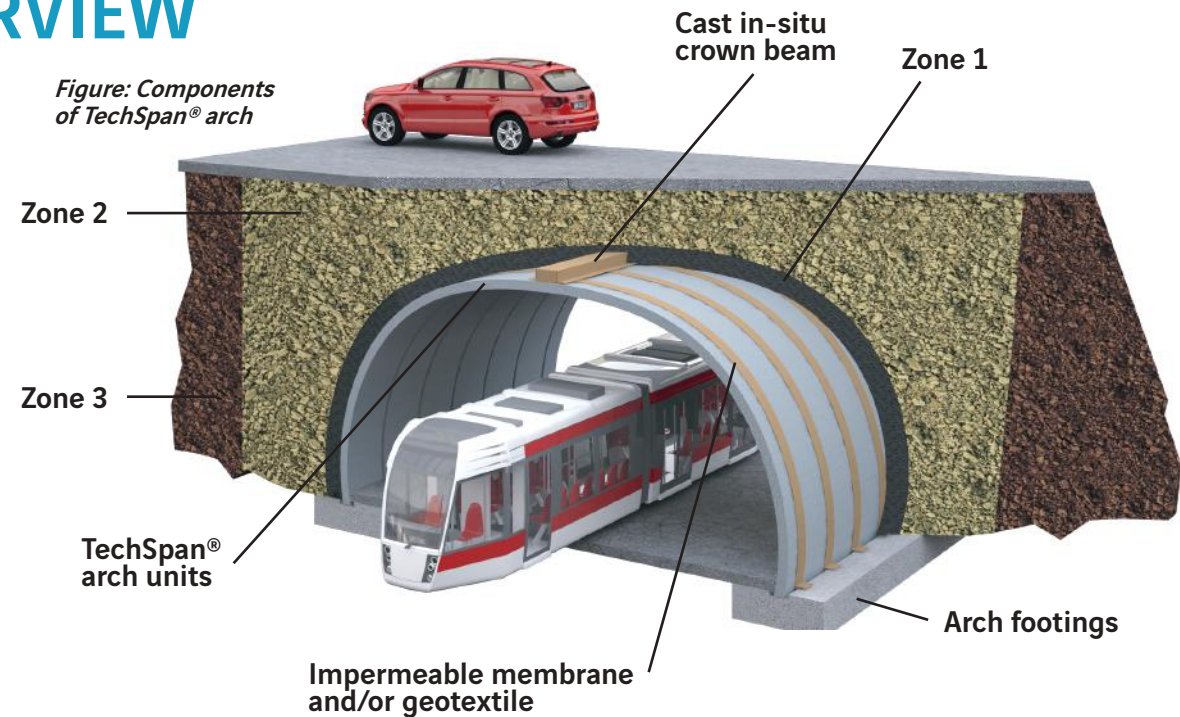
The span ranges from about 6m to more than 22m. Height ranges from about 30% to 70% of the span.

Its funicular curve minimizes the tensile forces in the arch, thus creating an axially compressed structure, leading to increased durability and costs savings.

TechSpan® technology results from decades of research and development. The system is designed to accommodate high fills, heavy live loads and altering loading conditions often associated with mining, industrial and railway applications.

This catalogue contains most of the common shapes suitable for roadways, railways and hydraulic applications.

With the support of sophisticated Finite Element Method (FEM) analyses, the loads on TechSpan® arches are verified for each step of construction including backfilling sequence.



The components defining a TechSpan® arch are the following:

- Arch footings (cast-in-place or precast);
- TechSpan® precast arch (male and female arch elements or single piece depending on the transportation limitations);
- Cast-in-situ crown beam (for longitudinal connection in the most cases, for stitching the crown in special cases where a 2 pin arch is required);
- Waterproofing whenever required or geotextile joint protection;
- The backfill (Zone 1, Zone 2 and Zone 3), placed and compacted in layers on both sides of the arch, complying with the Terre Armée Group specifications.



## SCOPE AND USE OF THIS CATALOGUE

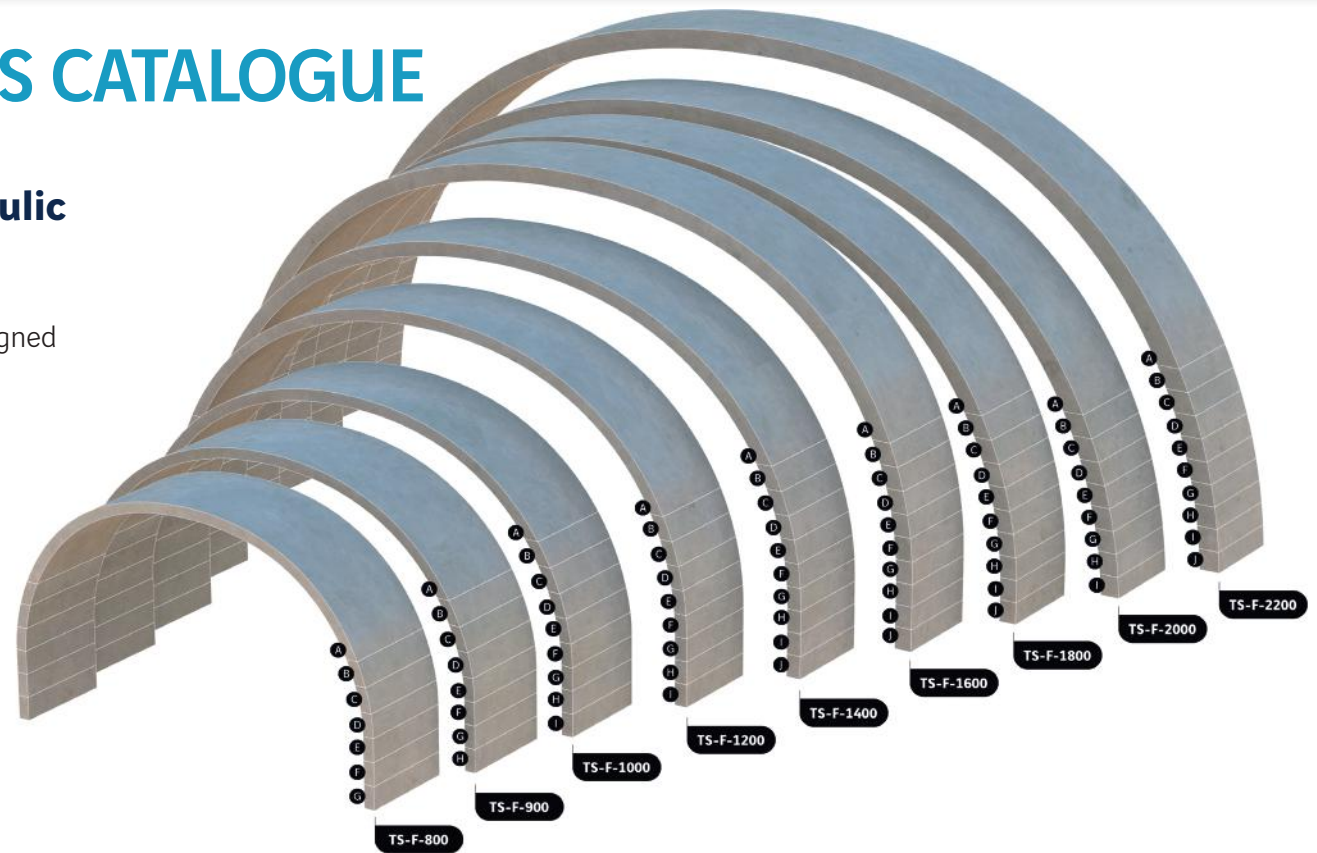
**The present catalogue contains most standard shapes suitable for non-hydraulic and hydraulic applications.**

All the shapes included in the catalogue have been pre-designed considering various parameters hereafter described.

**The designs herein shall not be used for execution drawings.**

There are 9 series of shapes, identified by TS-F\_XXXX: TS for TechSpan arch, F for funicular shape, and XXXX refers to maximum span of each shape (in cm). For each TS-series, several heights can be identified using the subscript with letters from "A" (representing the minimum height of the arch) to "J" (maximum height of the arch).

For each product, the catalogue provides the main arch dimensions and the reactions at the footings for several load combinations and various backfill heights.



The reactions on foundation are given for the following load cases (refer to section Design Methodology):

- **Arch SW:** erection of the TechSpan® arch
- **BL:** permanent full backfill Load
- **LLA:** Live Loads axial
- **LLE:** Live Loads eccentric
- **SH:** 1.0 Seismic horizontal inertial load + 0.3 seismic vertical inertial load
- **SV:** 1.0 Seismic vertical inertial load + 0.3 seismic horizontal inertial load

These reactions, given with no load factor applied, can be used for a preliminary design of foundations. Except during for the erection stage, all reactions are given for 5 overfill heights over the crown (1m, 2m, 3m, 4m, 5m).

Hydraulic dimensions of TechSpan® shapes are given for the maximum flow rate.

**In case you may not find an appropriate structure within presented shapes in this catalogue, contact our nearest office and we will assist you in developing the most optimal and tailor made structure for your project**

## DESIGN METHODOLOGY

**This catalogue contains several pre-engineered series of shapes. Finite Element Model (FEM) analyses have been carried out for each shape using standard soil parameters for a preliminary evaluation of dimensions, internal stresses and reaction on footings.**

Calculations are carried out for different backfill heights over the crown (ie.: 1m, 2m, 3m, 4m, 5m) and a 5% maximum transverse grade of backfill. A soil density of  $20\text{kN/m}^3$  with a friction angle of  $30^\circ$  is considered.

The analyses take into account all the construction stages, starting from the erection of the arch to full backfill height.

Two live load combinations are considered:

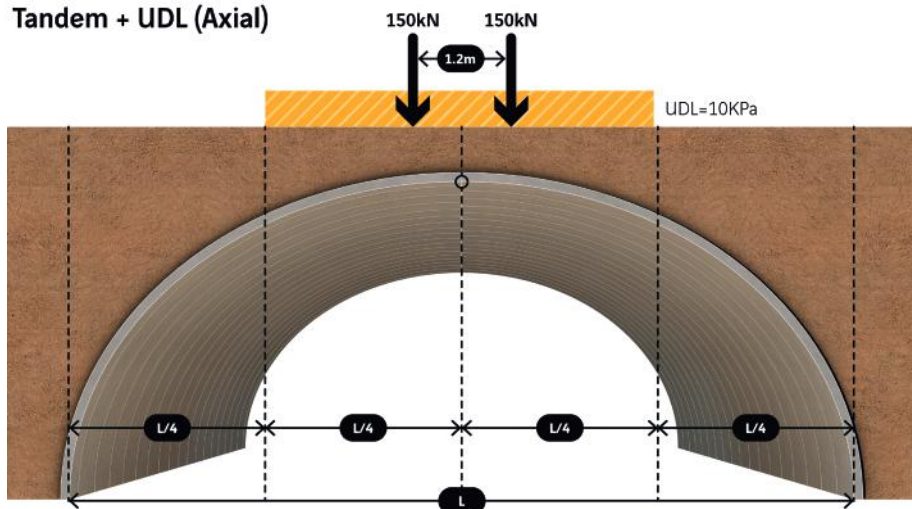
- an axial and eccentric tandem load
- an axial and eccentric distributed load (UDL)

Seismic loadings are considered with two combinations assuming a maximum design acceleration of  $0.3g$ , the first combination with dominant horizontal inertial loads and the second one with dominant vertical inertial loads.

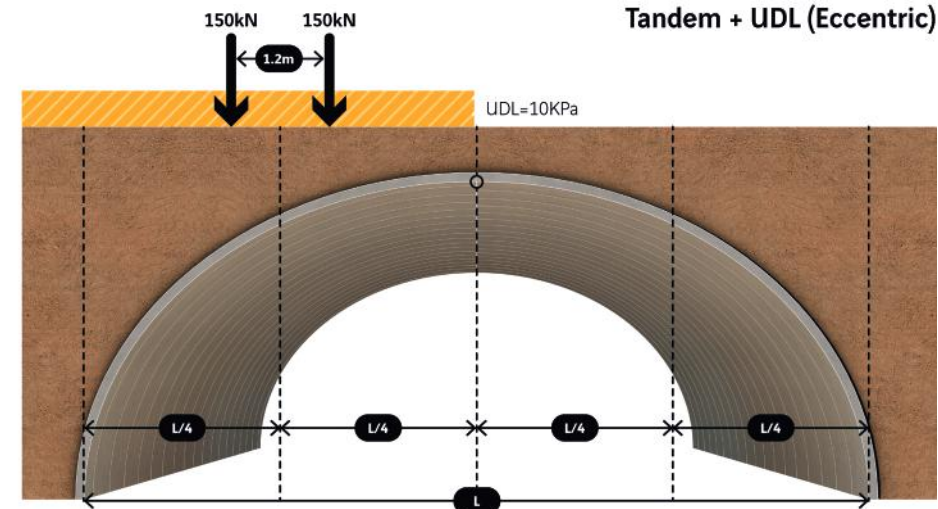
For the structural analysis, the following assumptions are taken:

- Concrete minimum characteristic cylinder/cube compressive strength of 30/37MPa
- Steel minimum yield strength 420MPa
- 40mm free cover

**Tandem + UDL (Axial)**



**Tandem + UDL (Eccentric)**



Further analysis needs to be carried out by the Terre Armée Group, for any other configuration, not covered in this catalogue.

**Contact us to confirm compliance with local requirements**



# SYMBOLS AND DIMENSIONS

## Span (S)

The span of the TechSpan® arch is the distance between the inner points of the legs at the base. The maximum span of each TS-series, expressed in cm, gives the name of the shape (for instance TS-F-800 series refers with the maximum span of 8 m).

## Height (H)

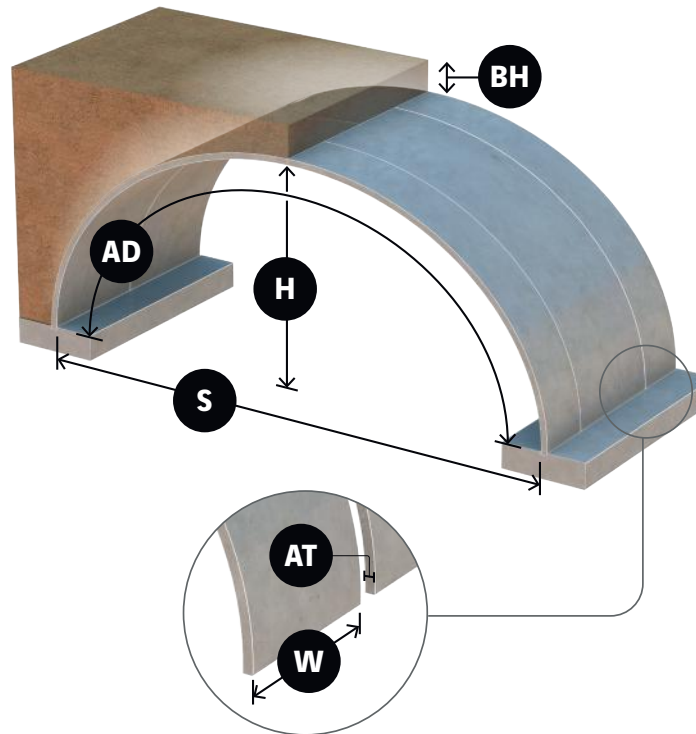
The height of the TechSpan® arch is the maximum vertical distance between the inner point at the crown and the base point of the legs. For each TS-series, the letters from "A" to "J" define different heights of the shape, with a difference in rise of 0,50m.

## Arch Thickness (AT)

The thickness of the TechSpan® arch is constant along the arch development.

## Width (W)

The weight of concrete elements is expressed in ton per unit width to easily identify the maximum weight and width of pieces according to local restrictions in terms of maximum dimensions and loads for regular transportation. Width is optimized on a project by project basis.

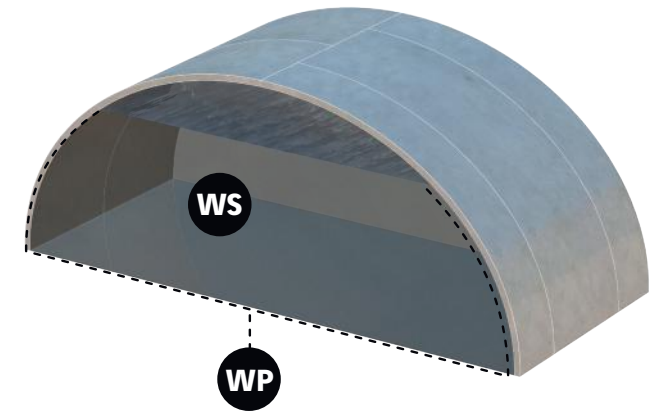


## Arch Development (AD)

The arch development is the total length along a cross section from base to base of precast unit.

## Backfill Height Over crown (BH)

The backfill height is the vertical distance between the finished grade and top of the crown at the centerline of the arch. The catalogue covers heights from 1 to 5 meters.



## Wet Surface (WS)

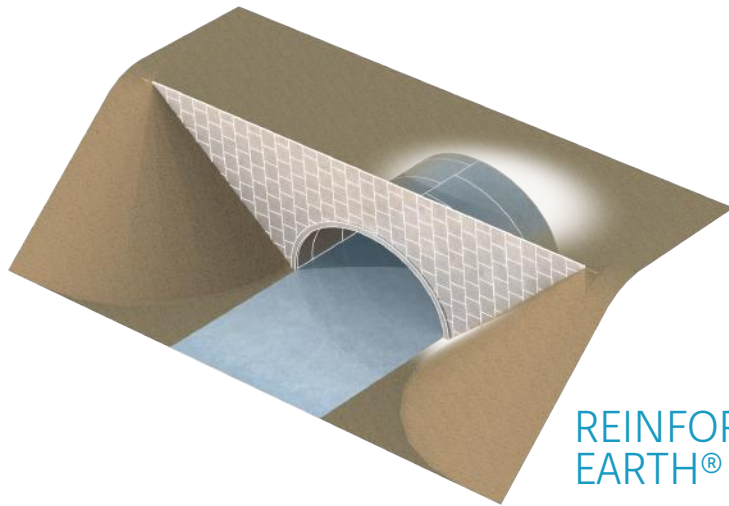
Used for hydraulic application of TechSpan®, the wet surface is the cross sectional area of water flow delimited by the water table and the horizontal line connecting the 2 lower points of the arch legs. For the estimation of the wet surface, a minimum freeboard of 1m between the inner crown point and the water table is considered.

## Wet Perimeter (WP)

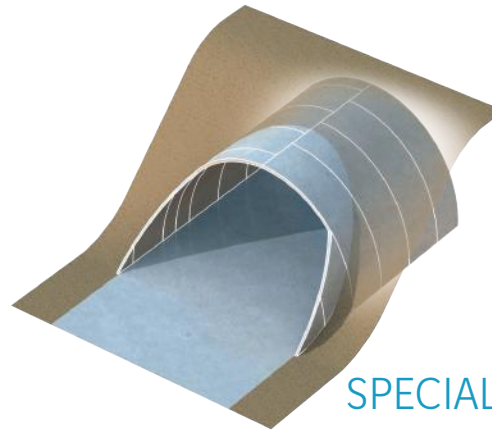
Used for hydraulic application of TechSpan®, the wet perimeter is the sum of the lengths of each side of the wet surface, excluding the water table, inside of the 2 arch units, and the horizontal line connecting the base of those units.

For the estimation of the wet perimeter, a minimum freeboard of 1m between the inner crown point and the water table is also considered.

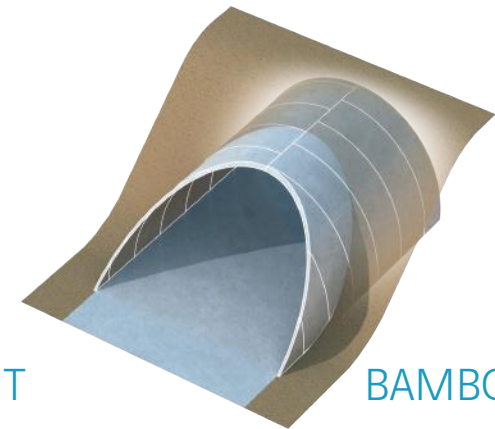
## TECHSPAN® END CONFIGURATIONS



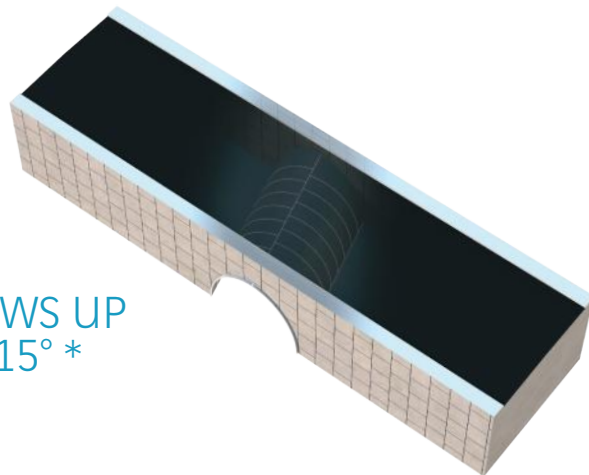
REINFORCED  
EARTH® WALL



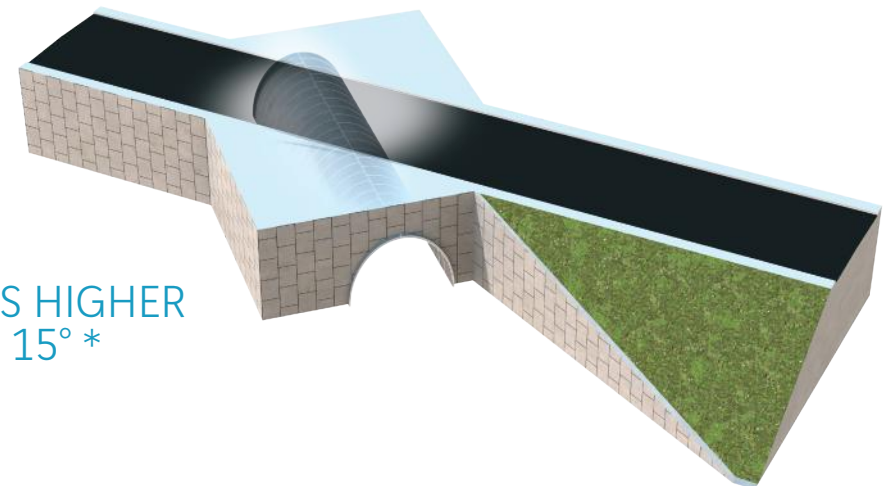
SPECIAL CUT



BAMBOO CUT



SKEWS UP  
TO 15° \*



SKEWS HIGHER  
THAN 15° \*

\* This value depends on span and standard segment width.

**Contact us to confirm compliance with local requirements**