# MSE bridge abutments – a structural solution


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## INTRODUCTION

French architect and engineer, Henri Vidal, invented a new material while playing with sand and pine needles on a Mediterranean beach in 1957. He named this revolutionary new material "Reinforced Earth". The material proved to be both versatile and cost effective and its use spread rapidly throughout the world. By the early eighties a new industry had been created and the generic name for the material became Mechanically Stabilised Earth, or MSE for short.

The basic mechanics of Reinforced Earth were well understood by Vidal and were explained in detail in his early publications, and are illustrated in Figure 1. An axial load on a sample of granular material will result in lateral expansion in dense materials. However, if horizontal reinforcement elements are placed within the mass these reinforcements will prevent lateral strain because of friction between the reinforcing elements and the soil, and the behaviour will be as if a lateral restraining force or load has been imposed on the element. As the vertical stresses increase, the horizontal restraining stresses also increase in direct proportion. The horizontal strain of the earth is captured by the reinforcing elements. Failure can only occur should the reinforcing strips fail, or if the frictional bond between the reinforcements and the earth is lost.

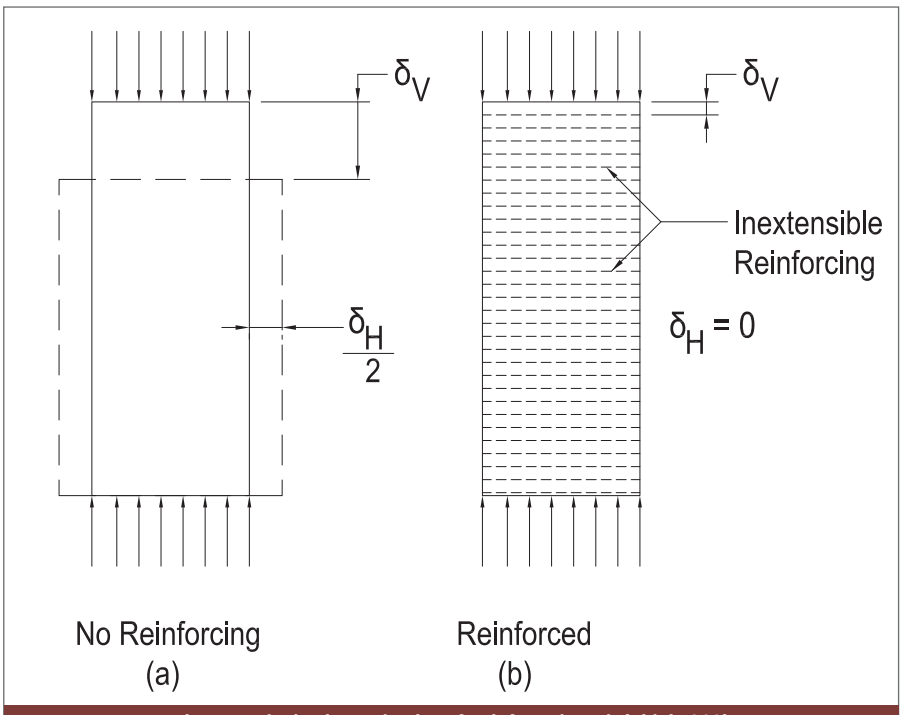



**Figure 1: The basic mechanics of Reinforced Earth (Vidal 1960)**

MSE is then a composite material, combining the compressive and shear strength of compacted frictional fill with the tensile strength of horizontal reinforcements. The material displays the flexible properties of earth, while behaving as a coherent gravity mass.

## THE BACKFILL

The granular earth material should meet grading and electro-chemical specifications to ensure stability and durability of the reinforcements

## THE CLADDING

Originally conceived as a 'skin' the cladding forms the physical and visual front of the structure, and is designed to hang off the earth reinforcements and not introduce any stiffness or to inhibit the flexible properties of the MSE. The cladding is positively connected to the reinforcements. The positive connection ensures that, should the lower cladding elements be undermined or settle, they will still be intact.

## THE REINFORCEMENT

The two basic types of reinforcement of MSE reinforcements are inextensible (steel) and extensible (polymeric). Extensible reinforcements will strain under load to the extent that the strain in the reinforcement may equal the strain in the soil mass accompanied by lateral

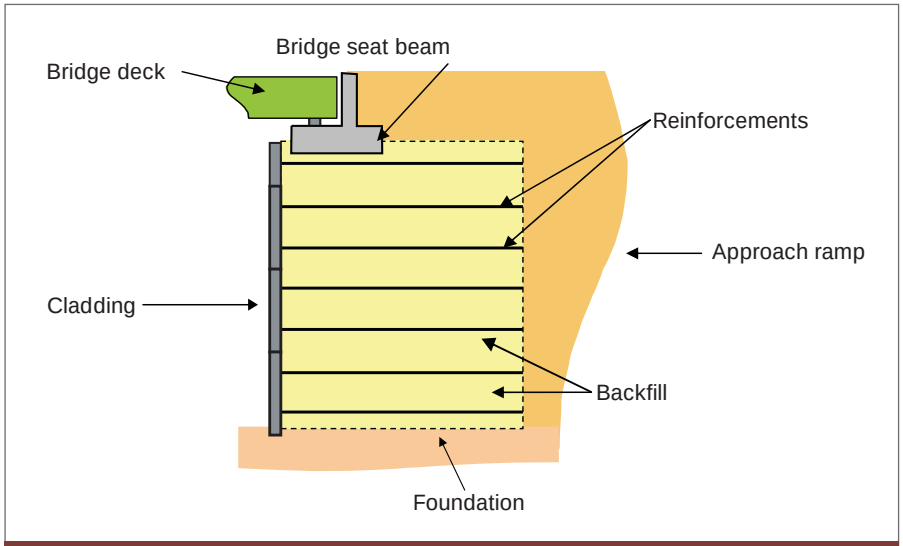
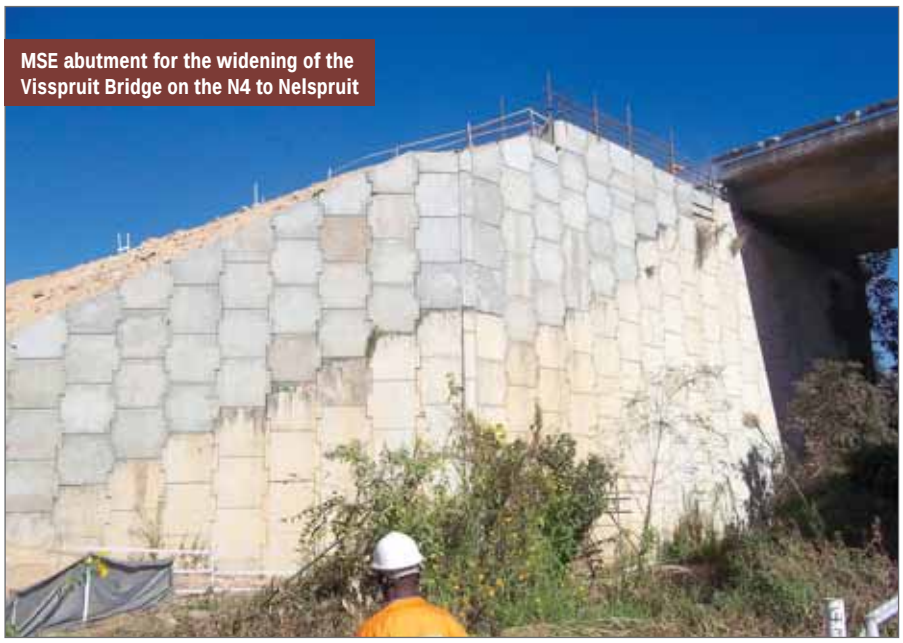



**Figure 2: Reinforced Earth bridge abutment**



**MSE abutment for the widening of the Visspruit Bridge on the N4 to Nelspruit**

**Bypass in Mbabane – a clear illustration of an MSE bridge abutment**

movement of the retained fill and facing. In most international codes, as well as the SANS 207:2006, the post-construction internal strain is limited to 0.5%.

## MSE BRIDGE ABUTMENTS

MSE was first used as a bridge abutment in South Africa in the late seventies. Since that time numerous MSE bridge abutments have been constructed in South Africa and several other African countries.

## THE BRIDGE SEAT

The loads from the bridge deck are transmitted by way of a reinforced concrete distribution beam, which rests on the MSE mass and which is proportioned to efficiently transmit the vertical and horizontal dead and live load from the bridge deck into the MSE mass.

## THE MSE STRUCTURE

The MSE sub-structure is designed to support its own mass, the earth pressures of the approach fill and the loads transmitted from the bridge deck by way of the distribution beams.

## THE FOUNDATION

The MSE structure is generally founded on earth which may be compacted fill or may be in the in-situ ground. Nominal embedment of the structure is required, unless the founding is on rock. In extreme cases the in-situ founding material may need to be improved by replacement or other foundation improvement techniques.

## ADVANTAGES OF MSE ABUTMENTS

MSEs are frequently used for abutments on compressible foundation soils. Settlements of the MSE abutments, both during and after construction, occur together with the approach embankments and need not be detrimental to the works. Settlements which take place after placement of the distribution beams must, however, be taken into account. Construction settlements can be monitored by placing a mark on the cladding and monitoring its settlement during the construction as a function of the height of the abutment fill and the date. Once the construction is complete the post-construction settlement can be extrapolated. The post-construction settlements are of little consequence for simply-supported bridge decks, provided longitudinal profile and clearance are considered.

MSE abutments do not require deep foundations, and since all construction

takes place from behind the cladding, they are often used for road-over-rail structures where space may be limited and deep excavations are not possible.

MSE abutments allow the simultaneous construction of approach embankments, retaining walls and abutments, all under the same earthworks operation. This is particularly useful in the case of poor foundations. An advantage of MSE abutments is that there is a smooth transition from approach embankment to abutment to deck, eliminating the bump at the bridge caused by differential settlements. For deep decks the distribution beam has a high back wall and a transition slab may be required to counter the differential settlement and consequent bump at this transition.

Bridge abutments at the Gautrain Marlboro underpass

With proper planning the use of MSE abutments can also lead to speedy widening of existing bridges. This was recently illustrated in the widening of the Visspruit and Cairnspruit bridges on the N4 towards Nelspruit, 30 years after the original construction.

Southern Africa is not particularly earthquake prone, but in earthquake regions MSE abutments are well known to be able to absorb dynamic loads.

## CLOSING REMARK

MSE bridge abutments are the domain of the bridge engineer. The foundation and the nature of the backfill is the domain of the geotechnical engineer. Structural engineers should, however, be aware of MSE and take advantage of the material's properties when the opportunity arises. □



Source:

http://www.saice.org.za/downloads/monthly_publications/2013/2013-Civil-Engineering-March/#/0

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