

# The influence of the passive earth pressure on the stability of the underground masonry vaults of the Paris metro

O. Moreno Regan\*, E. Bourgeois<sup>†</sup>, JF. Douroux<sup>††</sup> and A. Desbordes<sup>††</sup>

\* setec tpi

Immeuble Central Seine - 42-52 quai de la Rapée 75583 Paris, France  
e-mail: [omar.moreno-regan@setec.com](mailto:omar.moreno-regan@setec.com) , web page: <https://www.setec.fr/en/>

<sup>†</sup> Université Paris-Est, IFSTTAR

14-20 Boulevard Newton, Cité Descartes, Champs sur Marne  
F-77447 Marne la Vallée Cedex 2, France  
email: [emmanuel.bourgeois@ifsttar.fr](mailto:emmanuel.bourgeois@ifsttar.fr) - web page: <https://www.ifsttar.fr/en>

<sup>††</sup>RATP

50 Rue Roger Salengro, 94724 Fontenay-sous-bois, France  
e-mail: [jean-francois.douroux@ratp.fr](mailto:jean-francois.douroux@ratp.fr), [alain.desbordes@ratp.fr](mailto:alain.desbordes@ratp.fr)  
web page: <https://www.ratp.fr/en>

## ABSTRACT

This paper presents an analysis of the behavior of masonry tunnel vaults of the Paris metro when their state of equilibrium is altered. These tunnels were built predominantly in the early twentieth century and about 85% of them are comprised of a masonry vault combined with sidewalls and a slab made of unreinforced concrete. Given the materials used and the construction method, these tunnels are not self-equilibrated structures, they need the lateral reaction of the ground to balance the horizontal thrust generated by the masonry vault. When nearby construction work is carried out, for instance, new tunnels or excavations, the ground stiffness around the tunnel may decrease resulting in the loss of the necessary passive earth pressure that ensures equilibrium of the structure. The main case studied here is that of the spreading of the vault's supports. This leads to a formation of cracks in the structure and failure may occur with the formation of a hinge mechanism in the tunnel. In order to study this particular phenomenon, numerical computations are carried out using a specifically developed model that combines a homogenization technique with damage models at the scale of the masonry constituents to establish a more accurately constitutive law for the masonry [1], [2]. An interface between the tunnel and the ground allows the study of the soil-structure interaction. The proposed model identifies the possible hinging failure mechanisms and their configuration based on the horizontal displacements and the geometry of the structure. Several other simpler constitute laws for the masonry are also used and then compared with the proposed model [3]. Benefits and limitations of each model are presented. Quantitative results on the loss of the passive earth pressure and the deformation of the structure are also provided. Based on the numerical simulations made and real measurements, it was observed that the studied underground masonry vaults may withstand several centimeters of support spreading.

## REFERENCES

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