**Reviewer #5:**

In this manuscript, the authors study rock deformation in twin tunnels with a transverse gallery, considering plasticity and time-dependent constitutive models. After reviewing the manuscript, I believe the following questions should be addressed in the revised version:

**\*\*1) The title could be changed to "Evaluation of Rock Deformation in Twin Tunnels with a Transverse Gallery, Considering Plasticity and Time-Dependent Constitutive Models."**

Thank you for your suggestion regarding the title. We agree that the proposed title better reflects the focus and scope of the study. We have also decided, at the suggestion of another reviewer, to make it explicit in the title that the article deals with a three-dimensional finite element model. Therefore, we have revised the title to: *"*A three-dimensional finite element evaluation of the rock deformation in twin circular tunnels with a transverse gallery considering plasticity and time-dependent constitutive models.”

**\*\*2) Is the twin tunnel mentioned in Section 5 an actual case study? If so, the geotechnical properties, as well as details regarding the size, excavation method, and lithological units of the study area, should be provided.**

The twin tunnel mentioned in Section 5 is not a case study, but a typical configuration used to verify and demonstrate the application of the developed numerical model. The geometrical properties, material parameters, and boundary conditions were defined based on data from the literature and some assumptions (referred to Section 2). There are no specific twin tunnels with geotechnical data, excavation methods, or lithological unit details, as the study aims to explore generic scenarios of interaction between twin tunnels and a transverse gallery.

To make it clearer, this point has been incorporated into Section 5: "Spatial and Time Discretization of the Domain", after introducing the model geometry and conditions, before Table 1 with geometrical parameters, with the following text:

"The twin tunnel configuration is a typical setup designed to verify and illustrate the applicability of the proposed numerical model. The geometric parameters and boundary conditions are common to twin tunnels configurations and the material properties were based on real data from the literature (see section 7.1), however they do not correspond to a specific twin tunnel case study."

**\*3) Which software was used for simulating the tunnel?**

The software used was ANSYS, but it is important to note that the constitutive models (for the rock mass and lining) were developed and implemented within it using the UPF/USERMAT feature. The software doesn't have these advanced models. This information is in the text of the article:

The last paragraph in Section 1:

“[…] At the tunnel structure level, the constitutive modeling ~~and related~~ as well as the related numerical integration schemes are developed and implemented within a specific UPF/USERMAT procedure of ANSYS standard software (ANSYS 2018). The finite element modeling developed in this paper can be viewed as specifically devised tool for addressing the three-dimensional interaction induced by the construction process of closely-spaced twin tunnels with transverse gallery junction. […]”

For the rock mass, in the last sentence of the first paragraph in Section 3:

“[…] Detailed description of the model, including application and validation in the context of single tunnel structures may be found in Quevedo et al. 2022b. Finite element implementation of this model in the USERMAT procedure of ANSYS software is also described in Quevedo 2021.”

And for the lining, in the last sentence of the first paragraph in Section 4:

“[…] Full details regarding model definition and related finite element implementation may be found in Quevedo 2017 and Quevedo et al. 2022a.”

However, to make it clearer the last paragraph in Section 1 will be changed to:

“[…] The simulations presented in this paper were conducted using the ANSYS software suite, a widely used finite element analysis tool. However, to address the specific requirements of the research, these constitutive models were developed and implemented within ANSYS through a specific UPF/USERMAT procedure. At the tunnel structure level, the finite element modeling developed in this paper can be viewed as a specifically devised tool for addressing the three-dimensional interaction induced by the construction process of closely-spaced twin tunnels with transverse gallery junction. […]”

**\*\*4) How was the numerical model calibrated?**

The numerical model was not calibrated against a specific case study due to the lack of available data for twin tunnels exhibiting the considered constitutive behaviors. Instead, the material parameters used in this study were based on a well-documented deep clay rock, as detailed in Section 7.1. These parameters were calibrated from laboratory tests conducted by Rousset (1988), Giraud and Rousset (1996), Piepi (1995) and Giraud (1993), ensuring that the model reflects realistic mechanical properties. While this approach does not constitute a direct calibration to a field case, it provides a reliable basis for analyzing the time-dependent behavior of twin tunnels with a transverse gallery.

**\*\*5) How were the results of the numerical simulation verified?**

The results obtained from numerical models were partial verified by comparing them with analytical and numerical solutions available in the literature for similar configurations without transverse gallery in Section 6. For example, comparisons were made with the analytical stress solutions for twin tunnels under plane strain conditions proposed by Guo et al. (2021) and Ma et al. (2020). These comparisons demonstrated the ability of the model to capture the key interaction effects and deformation mechanisms.

To make it clearer, at the beginning of the reading, it will be added to the first paragraph in Section 6:

“This section is aimed at applying the computational modeling to simulate deformation and stress in two academic twin tunnels configurations. The first application refers to unlined twin tunnels excavated in an elastic rock mass, whereas the second application addresses the situation of unlined twin tunnels excavated in an elastoplastic medium. Since there are no case studies or even analytical/numerical derivations considering the coupled constitutive models in the context of twin tunnels with gallery, the numerical results provided in these illustrative applications may be viewed as preliminary verifications of the F.E. model.”

**\*\*6) The support systems of the tunnels and gallery should be clearly presented in a specified table.**

Thank you for your suggestion. Now, the support system parameters have been separated from the rock mass properties and are presented in Table 3 for improved clarity. This ensures a more structured presentation of the tunnel and gallery support characteristics.

**\*\*7) The boundary conditions, assigned material properties, and model size should be illustrated in the text.**

Thank you for your suggestion. To enhance clarity, the boundary conditions have been added after the third paragraph in **Section 5**. The model size is also described in the third paragraph of Section 5, with the domain dimensions and mesh details presented in Figure 5 and Table 1. The assigned material properties are now summarized in **Table 2** and the newly added **Table 3**, which cover the parameters for the rock mass and lining, respectively. Due to the extensive nomenclature of these parameters, including them fully in the text would be impractical. Therefore, we have opted to maintain a concise presentation in the tables while ensuring they are properly referenced in the manuscript.

**\*\*8) How were the normal and shear stiffness between the initial and secondary support systems considered in the model?**

The concrete lining is modeled as a continuous medium with constant thickness, without distinguishing between initial and secondary support systems. To make it clearer, this answer can be emphasized in Section 2: "Fundamental Assumptions":

We changed the sixth item:

"The simulation excavation processes are carried out assuming a constant tunnel advancement rate (i.e., constant excavation speed), together with a constant thickness."

to:

"The simulation excavation processes are carried out assuming a constant tunnel advancement rate (i.e., constant excavation speed), together with a constant thickness of concrete lining without distinguishing between initial and secondary supports.”