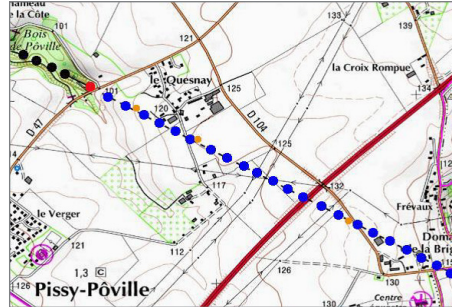


## Modelling of worksite ventilation for tunnels: SNCF Réseau

### The Background



On the 1st of January 2014, SNCF Réseau became the operator of the French rail system as a result of the promulgation of a law by Parliament to reform the 30,000km system, of which 2,024km is allocated to high speed travel. The company employs 52,000 people, transporting more than 5 million passengers and 250,000 tonnes of merchandise each day.

SNCF Réseau's responsibility is to renovate some of the 1,742 tunnels, constituting 637km of the country's rail infrastructure, most of which are more than 100 years old. Two of these older tunnels can be found near the farming village of Pissy-Pôville, in the Haute-Normandie region in northern France on the line between Rouen and Le Havre. Renovation of the tunnels, one of which is 2.2km long and the other 200m, started in October 2015 and is scheduled to finish in March 2017.

Without the correct ventilation, working conditions in the tunnels can be extremely dangerous as a result of concrete dust generated when spraying the walls and exhaust fumes from large machinery. For most of the tunnels, SNCF Réseau uses 1D model which produces fast, efficient results to evaluate the characteristics of the fans required to decrease concentration of pollutants. However, for some complex tunnels or worksites, SNCF Réseau has gradually developed 3D CFD models to predict ventilation and the influence of the presence of trains or engines. As the Pissy-Pôville tunnels are more complex, accurate data was required and construction trains had to modelled, they decided to call on Renuda's expertise to model the tunnels using 3D CFD tools.

### The Challenge

Although modelling ventilation is not unique to the tunnelling industry, it is relatively unusual to produce models that replicate working conditions in tunnels and the first time that SNCF had undertaken such a project. Renuda, faced with the challenging task of creating CFD representations that could be validated against experimental data which had been collected over a period of time and under different working conditions, also had to produce a working model which could be used for future projects. The presence of construction trains in the tunnel, different train configurations, contrasting roof heights and wall textures, forced and natural ventilation, were all factors which influenced the results and required careful consideration.

Geometric parameters such as slope, length, curve, positioning of the safety cells and ventilation shafts and the shape of the tunnel all have an impact on ventilation flow, therefore each of these aspects had to be studied before simulation modelling could begin. In instances where site visits were not possible, photographs gained from various sources were used to gain a better perception of the size of the construction trains in relation to the tunnels and the distance of the trains from the tunnel walls. Basic, as well as detailed, construction trains had to be modelled to establish what influence the train's shape has on ventilation.

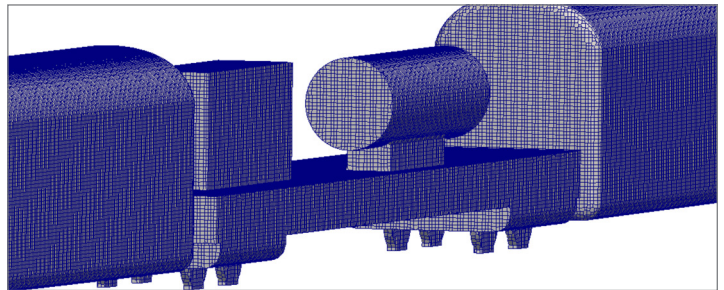


***"In terms of railway tunnel modelling the project was not revolutionary. It was, however, the first time SNCF Réseau had undertaken such a project for worksite ventilation."***

***Dr. Elisa Beraud***  
***Aérodynamique, aéraulique et sécurité en tunnel,***  
***SNCF RÉSEAU***

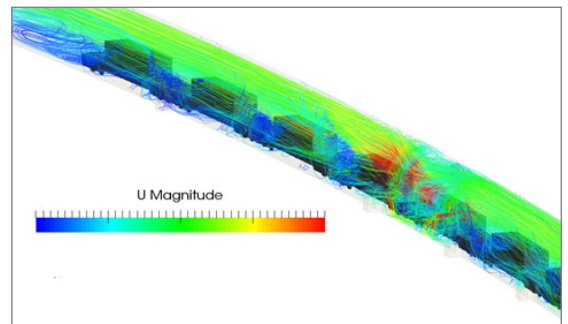
## The Solution

- A parametric study was conducted by carrying out a series of simulations for different configurations and comparing the predicted ventilation flow in the tunnel against the values measured experimentally by SNCF Réseau.
- Renuda modelled a generic, block shape construction train and a more detailed one, rough and smooth tunnel walls, natural ventilation and forced ventilation settings. These representations were used to validate different modelling approaches against the experimental data.
- Ventilation in the tunnel was simulated during construction and in the presence of construction trains.
- Having determined the main parameters and the simulations matrix with SNCF Réseau, Renuda assembled an entire OpenFOAM model including creating the tunnel CAD from scratch using plans and surface data surveys, meshes, a task that was influenced by the size of the tunnel, and the setups which had to consider the possibility of natural ventilation.
- As part of the parametric study Renuda had to determine the best way of applying boundary conditions in the tunnel, a significant decision which was influenced by the presence of the ventilation shafts.



## How SNCF Réseau Benefited

- As a result of the high correlation between the experimental data and the simulation results, the OpenFOAM model, in particular the simulated construction trains, will be used for future projects.
- Based on the positive comparison between experimental and simulation data, SNCF Réseau now have the ability to replicate these results for similar situations, thereby saving time for future projects and increasing the safety of their employees.
- The length of time taken to complete the project was reduced as a result of the solutions proposed by Renuda for the project's matrix of calculations.



***“Renuda was able to create a reliable representation of the construction trains which we will be able to use for future projects.”***

## Why did SNCF Réseau choose Renuda?

- Teamwork, trust and an understanding between the two companies as a result of working together for a number of years on tunnel ventilation projects.
- A combination of SNCF Réseau's rail expertise and Renuda's modelling experience encourages innovative solutions, saving valuable project time.
- Renuda's reliability and flexible approach to problem solving.

***“It is nice to have reliable, easy going people to work with who understand our requirements and the standard of work we expect. Based on years of experience of working with them, I would recommend Renuda without hesitation.”***

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