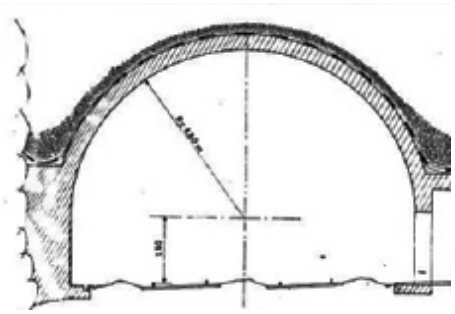
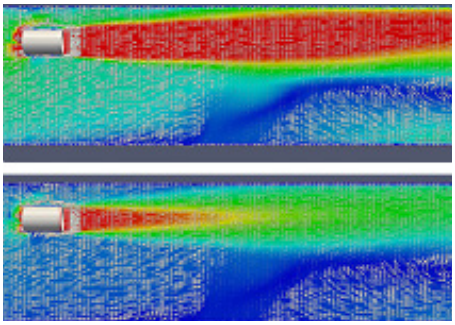
Case Study

RENUDA
FLUID SOLUTIONS

Ventilation flow in tunnels: SNCF





The Background

SNCF is a world leader in mobility for goods, people and logistics, present in 120 countries, generating revenue of €32.2 billion with a total workforce of 250,000 (2013). Their status as international leaders in conventional and high-speed railway lines is confirmed by the 10 million commuters making use of their services daily.

The French rail network comprises approximately 1380 active rail tunnels, some of which were built over a hundred years ago, with a combined length of over 600km. Regeneration work is regularly conducted that may produce dust and toxic gases in concentrations high enough to pose health and safety risks. SNCF Infrastructures, responsible for maintaining and regenerating tunnels in compliance with AFTES's (French Tunnelling and Underground Space Association) code of practice, is responsible for ensuring the supply of sufficient ventilation and air flow in tunnels and underground building sites thereby averting possible respiratory problems for workers and passengers.

"What I liked about Renuda is that they were very interested in the project from the beginning; they asked a lot of questions to make sure they understood correctly what I wanted. Renuda proposed sensible solutions based on this informed understanding"

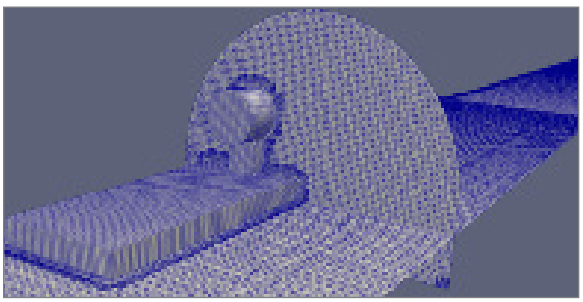
Elisa Béraud

Aerodynamics & Aeraulics, SNCF

The Challenge

There is a growing awareness of air pollutant danger in confined spaces and air quality is a growing concern for many companies who realise the importance of a safe working environment.

SNCF currently uses a 1D mathematical model to evaluate air quality and ensure a safe working environment for tunnel or underground station works. However, this 1D model works well for relatively simple, straight tunnels, but is not sufficiently accurate for tunnels with complex geometries.



The challenge was to establish whether 3D Open Source CFD software calculation chains would be more effective than the 1D mathematical model in identifying fan characteristics and their position in complex tunnels, within an acceptable time frame.

A positive outcome in the findings would extend the simulation project to commissioned work scheduled at the Gare Du Nord underground train station in Paris in the near future.

The Solution

For two types of tunnels, an open source, 3D CFD analysis chain was put together, consisting of SALOME to build the tunnel geometries and OpenFOAM® to volume mesh the two geometries and run the simulations. The Open Source visualisation code ParaView was then used to analyse the results.

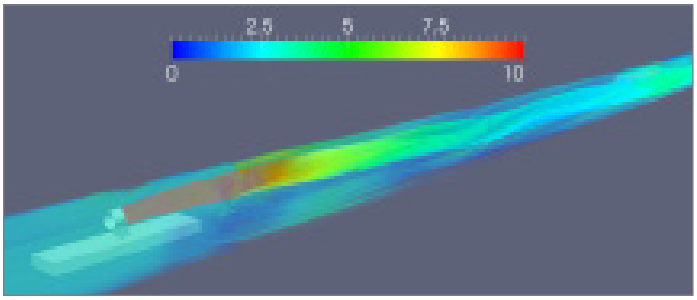
The first tunnel tested, Champvans, represents an example of a simple tunnel configuration whilst the second tunnel, St Martin d'Estreaux, is more complex and uses four vertical ventilation shafts for additional tunnel ventilation.

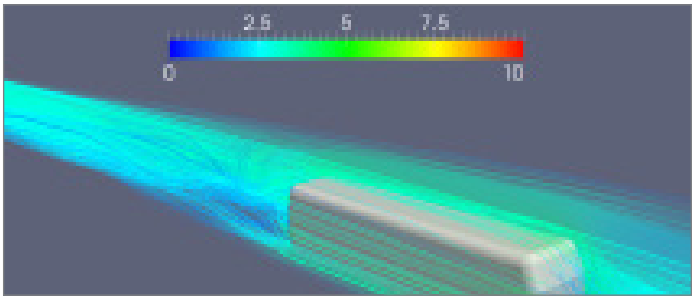
The simulation of forced ventilation in the 500m long Champvans tunnel considered two ventilator positions, with and without the presence of a locomotive in the tunnel. The simulation of the 1380m long St Martin d'Estreaux tunnel considered the impact of one and, subsequently, two ventilation fans for five different fan positions in relation to the ventilation shafts.

"I was surprised and happy with the results. I hadn't told Renuda exactly what I hoped to achieve, but they understood my requirements and made good suggestions; the results were what I wanted"

Elisa Béraud

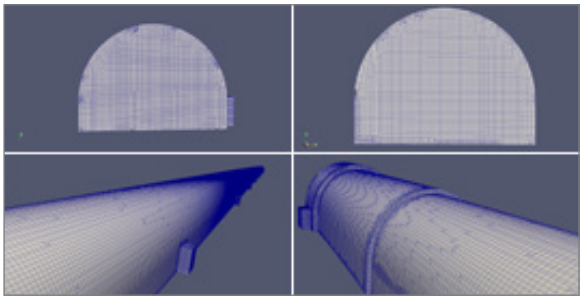
Aerodynamics & Aeraulics, SNCF





The Result

After analysing the results, SNCF was pleased that, on the whole, Renuda's results were compatible with its 1D calculations, giving them confidence in the open source results. Compared to the 1D simulations, the 3D models provided important additional information concerning the distribution of the flow circulating in the tunnel and ventilation shafts as well as the impact of the locomotive on the flow generated by the ventilator. The results also identified an optimal position of the ventilator and locomotive for tunnel ventilation.



How SNCF Benefited

Renuda's accurate 3D modelling provided SNCF with a better insight into airflows in the tunnels, facilitating informed safety decisions for an improved, safer underground working environment.

Renuda's 3D models allowed SNCF to visualise airflow for different ventilator positions and install smaller ventilators which are able to produce sufficient airflow throughout the tunnel, thus eliminating the expensive and inefficient solution of over-specifying ventilators based on the 1D model.

Due to the accuracy and reliability of Renuda's results, SNCF have improved their compliance with health and safety regulations.

Why did SNCF choose Renuda?

Renuda were selected ahead of four CFD consultancies to undertake the project. They demonstrated a genuine interest in the project and established themselves as highly skilled CFD software experts after successful completion of previous SNCF projects:

- A study to improve passenger comfort by optimising ventilation ducting in high speed trains.
- Two studies on the impact of cross winds on the Paris to Marseilles line.
- An aero-acoustic study of the front bogey on TGVs.

Renuda's consultants demonstrated a greater understanding of SNCF's problem by asking questions and understanding correctly what was required, thereby proposing solutions based on this informed understanding.

"It was pleasant and convenient for me to work with Renuda. We communicated by telephone, which was perfect for me. The Renuda consultants are very nice to speak to and exchange ideas with. This isn't always the case when using consultants – it is not easy to work with them if they are not on the same wavelength as you"

Elisa Béraud

SNCF Scientific and Technical Expert

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