

KURORTNY AVENUE RELIEF ROAD IN SOCHI

KURORTNY AVENUE RELIEF ROAD – MODERN HIGHWAY



The Kurortny Avenue relief road is a highway that passes through the districts of Jóstinsky and Centralny in the city of Sochi (Krasnodar Province, Russia). It is one of the alternative routes of Federal highway M27, and is the northern extension of the Sochi-Adler highway. It doubles the main street in Sochi, Kurortny Avenue, as well as the Obyezdnyaya highway. The project was part of the Federal Building and Infrastructure plan for the Sochi Olympics and for the development of the city of Sochi. This included the improvement of urban transport infrastructure commissioned by the Federal Highway Agency Directorate for Construction and Reconstruction of Motor Roads of the Black Sea Coast. The project was designed and the construction work supervised by JSC Institute Stroyproekt, and was carried out in three phases: The first phase from the river Agura to Zemlyanichnaya Street (5670m long); the second phase from Zemlyanichnaya Street to the river Sochi (5280 m long) and the third phase from the river Sochi to the river

Psaje (5330 m long). The contract for the first phase was awarded to "OAO "TO-44" company, and for the second phase to OAO Mostotrest.

General characteristics of the Project:

- Length: 16,3 km;
- Number of lanes: 4 (2 in each direction);
- Total length of artificial structures (viaducts, tunnels): more than 20 km (in 2 directions).

The relief road mainly consists of tunnels and viaducts. In all, there are 19 bridges and viaducts, 15 tunnels and 7 road junctions.

Estimated traffic speed: 75 km / h.

The 1st phase was opened to traffic without restrictions in January 2013. Phases 2 and 3 were opened to traffic without restrictions in February 2014.



Building of the tunnels

During the construction phase, ZITRON axial fans model ZVN 1-14-132 / 6 powered with 132 kW electric motors were installed to ensure the ventilation of the tunnels under construction. Interesting technical solutions used in the design and construction of the Kurortny Avenue relief road include the supports designed for high seismic risk, the original design of the frames for the slabs of the roadway, and the complex configuration of the curvilinear superstructure of one of the sections.

The Kurortny Avenue relief road project is one of a kind because it was completed in a very short time. The construction works were carried out in adverse conditions: mountainous terrain, seismic risk, unstable ground, existing urban infrastructure and strict environmental requirements. The project required the skills of highly qualified professionals throughout. The termination date imposed by the date of the Sochi Olympics required a high level of mechanization and equipment of the construction sites.



ZITRON ZVN 1-14-132/6 Fan



It is open to traffic without restrictions

Today the Kurortny Avenue relief road is the most modern transport infrastructure of the city of Sochi and represents the largest set of mountain road tunnels in Russia, all equipped to the most advanced level of technology. Throughout its entire length, the road is equipped with rainwater multi-step purification units, acoustic screens, and high-efficiency lighting systems.

The structure is built to withstand seismic loads up to intensity 9. It is equipped with an automated traffic control system, a video surveillance system, automatic weather stations and an automated speed control system. The tunnels are equipped with ZITRON ventilation systems for air quality control and for the safe evacuation of people through the passageways connecting the double tunnels.



Tunnel 2

VENTILATION MODES

The use of forced ventilation systems in the Kurortny relief road tunnels is conditioned by its length: the shortest one is over 600 m long. The main objective of the ventilation systems of the tunnels is to ensure compliance with the established parameters of air environment in a normal situation, as well as the safe evacuation of people in case of emergency. This double objective leads to two main modes of tunnel ventilation:

- normal mode
- emergency mode

EQUIPMENT FOR VENTILATION SYSTEMS AND SAFE EVACUATION

In virtually all of the Kurortny relief road tunnels, the ventilation system is designed and built with the use of ZITRON JZR**-**/** jet fans. This ensures a quality ventilation under normal conditions, and also enables the delivery of a sufficient volume of air for the safe evacuation of people in an emergency situation. The jet fans are installed in the tunnel ceilings in groups of 2, 3 units along the length of the tunnel, set away from the traffic area. The number of fans and their type will be determined by the particularities of the design of the tunnel.



Tunnel 4: Jet fans JZR 9-15/4

Jet fans operate by forcing the air to move: a relatively small amount of air within the tunnel is sucked in by the fan and subsequently expelled with high kinetic energy. This energy is transmitted to the rest of the air, causing all the air to flow longitudinally. The fans are designed to operate in both directions. Flow reversal is 100%.

The axial type jet fans JZR**-**/** are designed to operate as part of longitudinal ventilation systems for tunnels. The thermal load of the fan in a smoke evacuation system is 250 °C for a minimum of 2 hours. The fans are activated with soft starters, and their control is automated. 138 units are installed in the Kurortny relief road tunnels, with a total rated power of 3420 kW.



Tunnel 5: Jet fans JZR 12-45/4

In several tunnels, ventilation is in both longitudinal and transversal directions. Thus, in the double tunnel 8-8a, the maintenance of normal and emergency air quality parameters is further guaranteed by the use of ZITRON ZVN*-**_***/** axial extractor fans, in addition to the use of jet fans. Axial fans type ZVN*-**_***/** are also installed in the ventilation system of Tunnel 1 for emergency ventilation.

The axial fans ZVN*-**_***/** are designed to operate as part of the general ventilation, resisting temperatures up to 600 °C, the axial fans can work for a minimum of 2 hours in smoke evacuation mode.

The impeller is equipped with a mechanism for manual adjustment of the blades, provided the fan is stopped. A frequency converter is used to adjust operating parameters as well as to start the fan. The fan can be operated manually by means of a control panel, or remotely.

The ventilation system for all the tunnels of the Kurortny relief road comprises 6 axial extractor fans with a total rated power of 1300 kW.



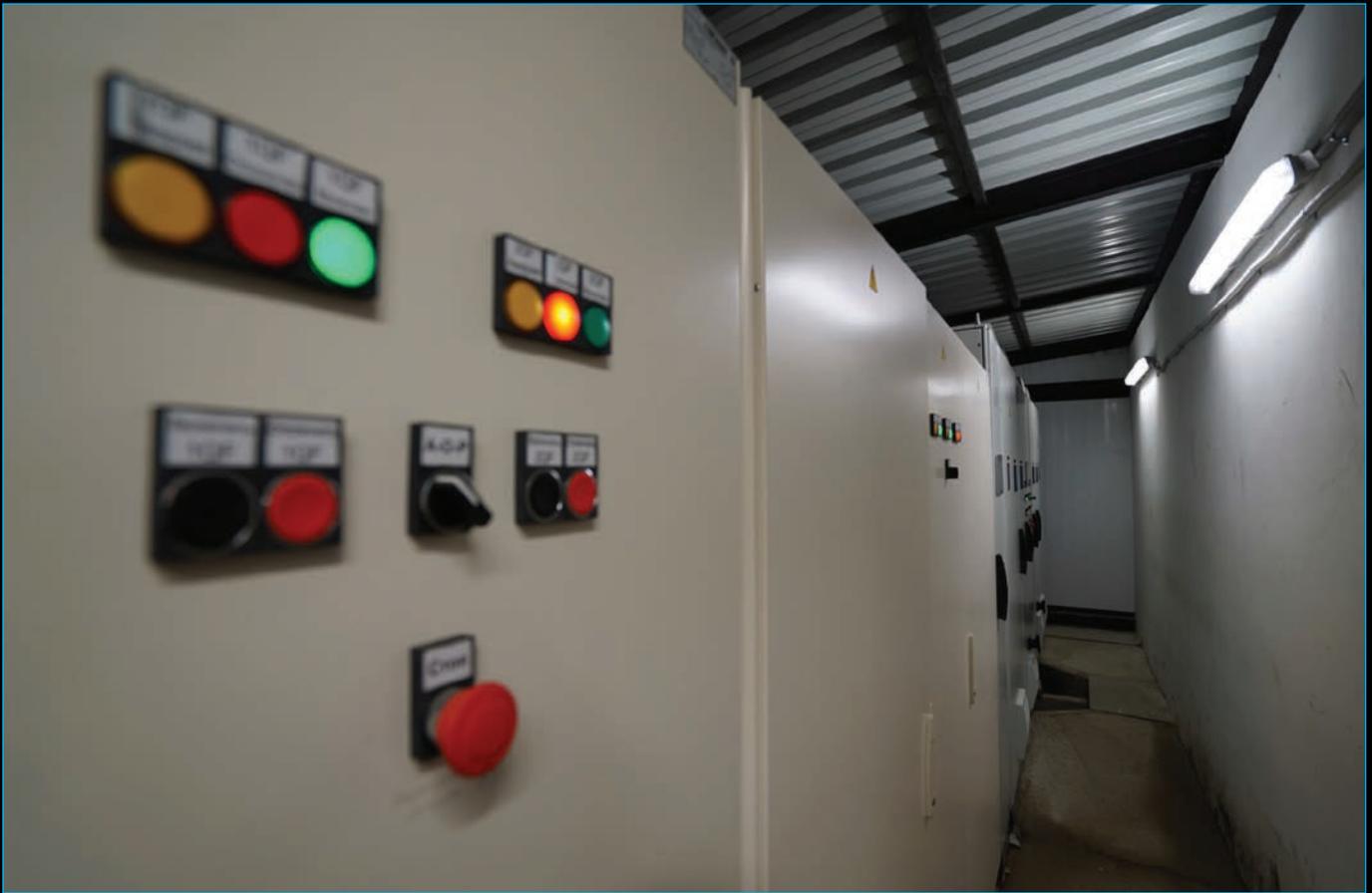
Tunnel 1: ventilation channel Valve



Tunnel 1: Axial fans ZVN 1-22-200/6

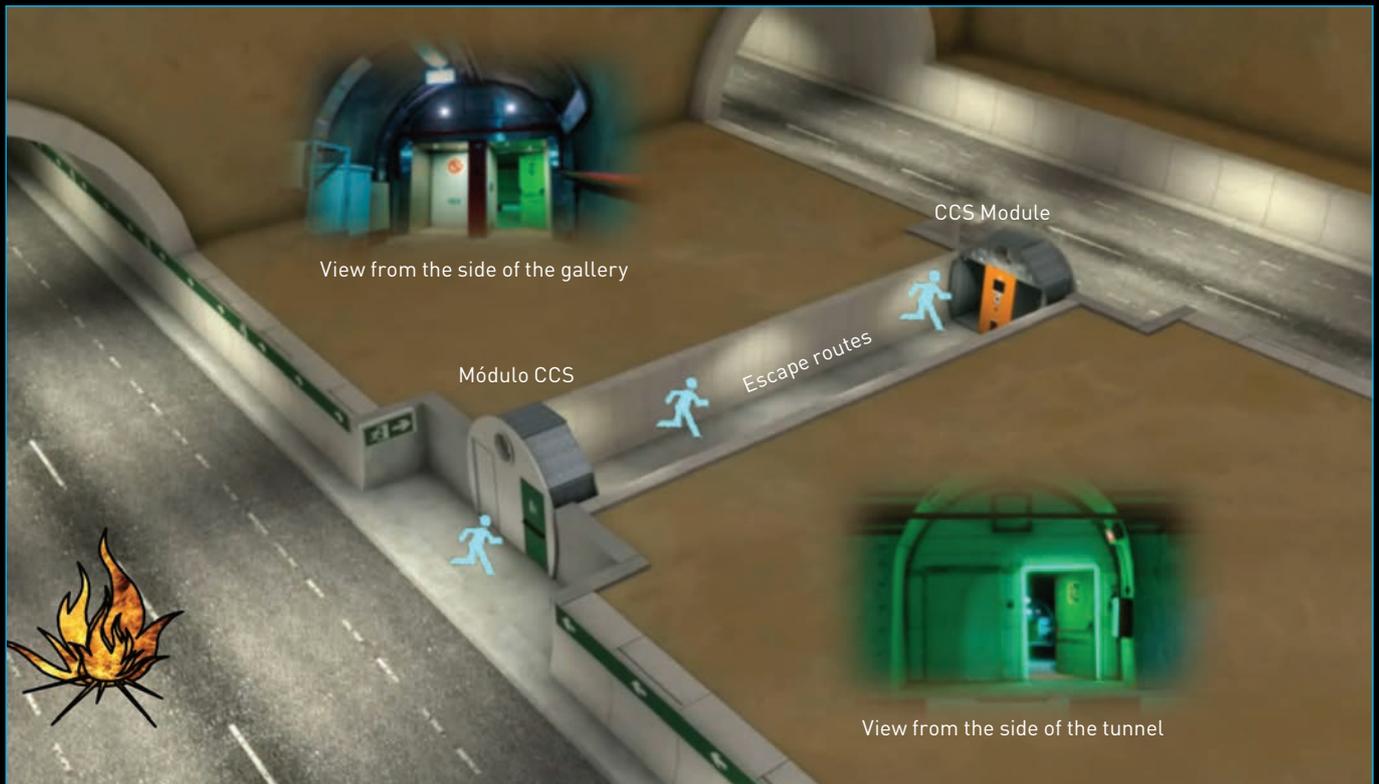
The axial extractor fans are installed in a special enclosure: the ventilation chamber - which is located outside the tunnel, and is connected to the fans through ventilation ducts. Ventilation channel valves, installed at the point where the ducts connect to the tunnel, ensure control of the airflow of the air that has been extracted.

Depending on the design of the ventilation ducts, valves can be placed horizontally or vertically. In the case of Tunnel 1, the ventilation channel exit point is connected to the tunnel above the false tunnel ceiling, and the valves are placed horizontally above the false ceiling.



Control cabinet

To ensure the safe evacuation of people in emergency situations, the passageways connecting the tunnels of the Kurortny Avenue relief road are equipped with ZITRON CCS safety modules.



CCS module operating principle

The CCS module is designed to facilitate a safe emergency evacuation of people through the passageways that connect two tunnels. The CCS module equipment maintains an overpressure in the passageways, preventing the entry of flammable products and allowing, in the case of fire, the safe passage of people from the damaged tunnel to the other tunnel.

In emergency situations, people entering the evacuation passageways will be detected by the door-opening sensors installed in the module. The CCS module operates in the following manner:

- Creation of overpressure in the connecting passageway by opening the valve and activating the fan in the 2nd (pairs) module. The second module, on the service side of the tunnel, will automatically adjust the fan speed to keep the inner pressure at 50 Pa, and so prevent entry of flammable products into the passageway.
- The door that opens onto the tunnel will be blocked, preventing access to the fire zone.
- The lighting in the module will be switched on.
- Information on the operation of the system will be sent to the control center.

Usually the CCS module is powered from the main electrical supply line. In the case of damage to the main supply line, the module will automatically switch to the redundant power feed line. In the case of failures in the power supply to the redundant line, the module will receive power from the UPS (Uninterrupted Power Supply). If required, the UPS of the paired module can be activated.

The CCS module is a prefabricated structure and its dimensions match those of the section of the connecting passageway where it is installed. The front elements of the CCS module are manufactured in materials with fire resistance EI90.

DIAGRAM 1. LONGITUDINAL VENTILATION MODE



The ventilation of the tunnels of the Kurortny Avenue relief road in normal operation is done by means of jet fans type JZR ensuring forced longitudinal ventilation.

The number of jet fans in each tunnel is determined by the need to comply with the parameters of air environment, to organize the safe evacuation of people, and to create favorable conditions for firefighting.



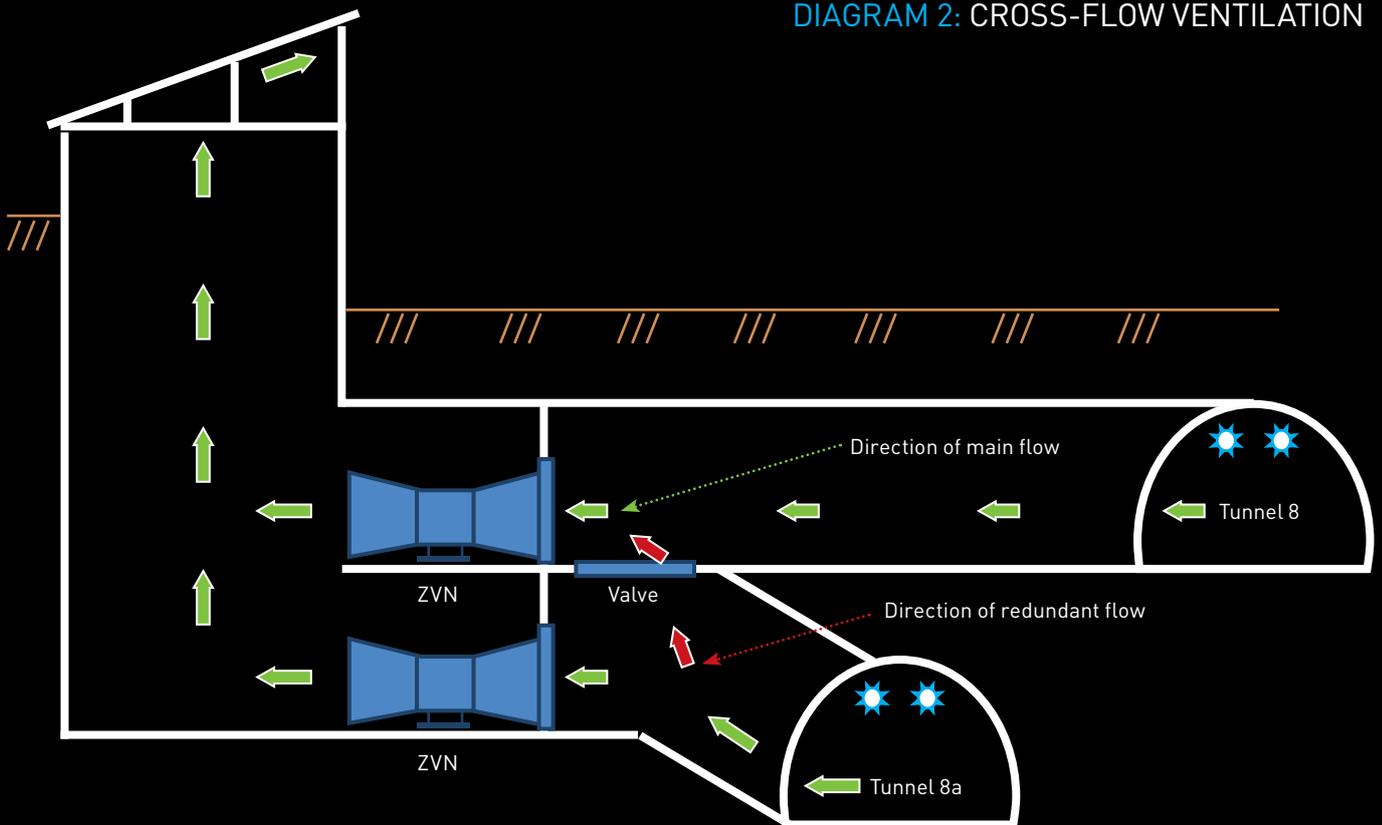
Tunnel 2, Southern portal: Jet fans type JZR 9-15/4

An emergency ventilation system is installed in tunnels 1, 8, and 8a of the Kurortny Avenue relief road. ZVN type jet fans are installed to ensure the forced cross-flow evacuation of fumes.

The extractor fans are located in the ventilation chambers on 2 levels that are connected with the tunnels through ventilation shafts, as can be seen in Scheme 2. 2 ZVN type fans are installed on each level. Each group of fans ensures smoke evacuation in the corresponding tunnel. In case there is a malfunction of a group of fans, the fans of the other group will be activated. This is the purpose of the valve installed between the channels which, when open, ensures that the flow is in the redundant direction.

As illustrated in Diagram 1 JZR type jet fans provide the normal ventilation system in tunnels 1, 8, and 8a.

DIAGRAM 2: CROSS-FLOW VENTILATION



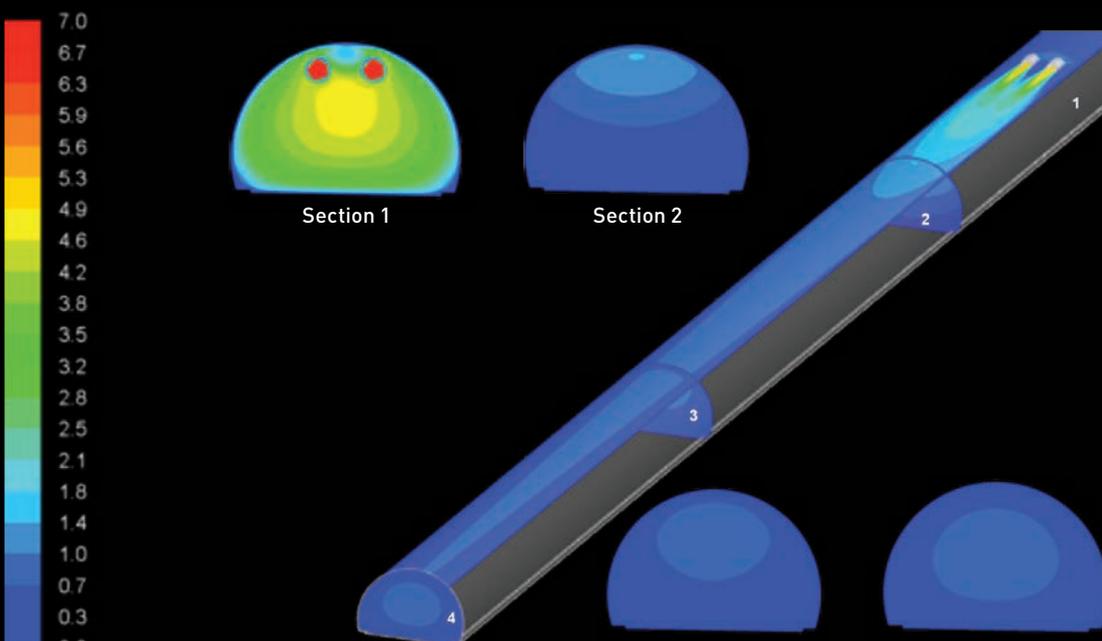
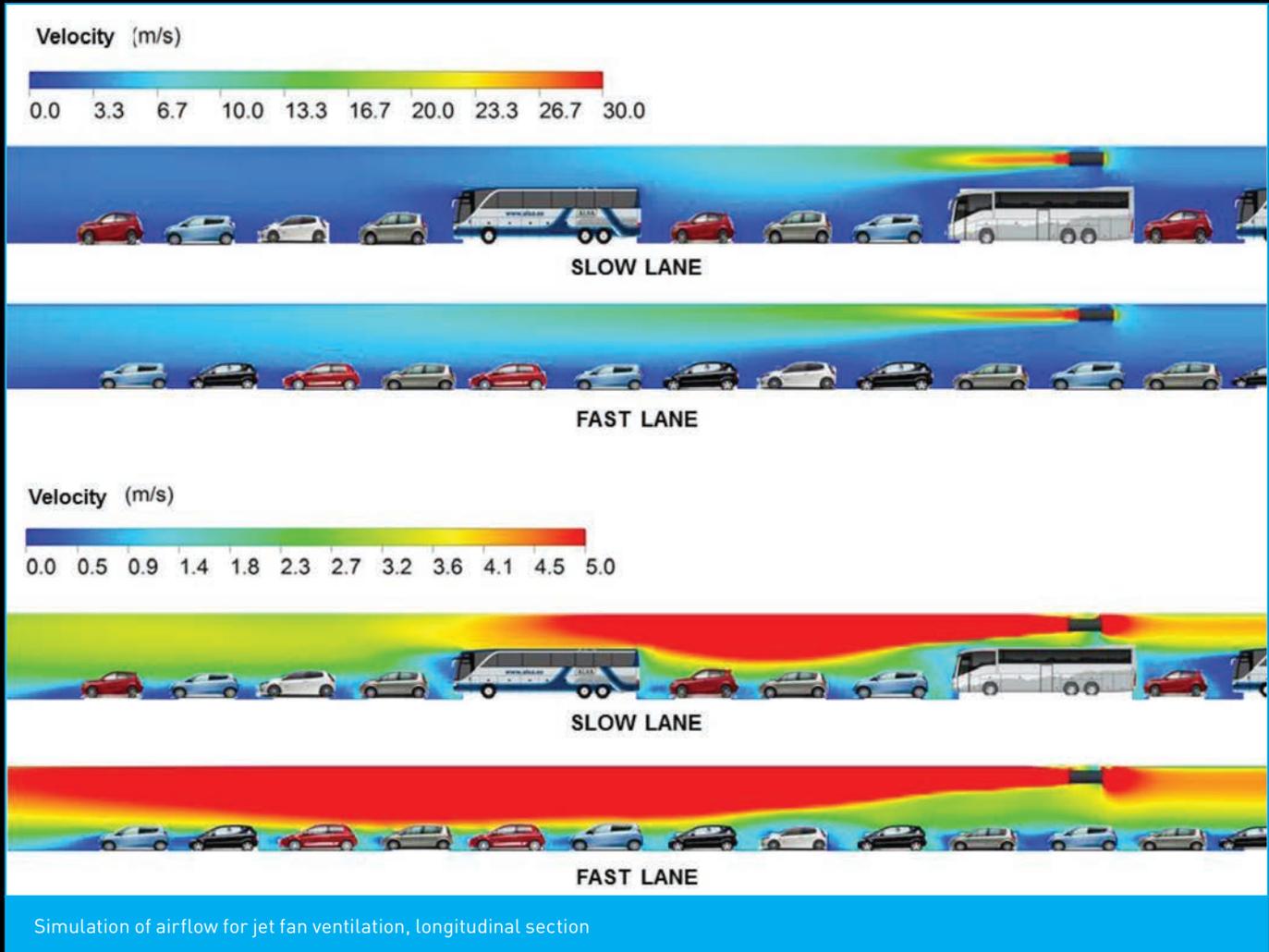
ZVN fan in tunnel 8



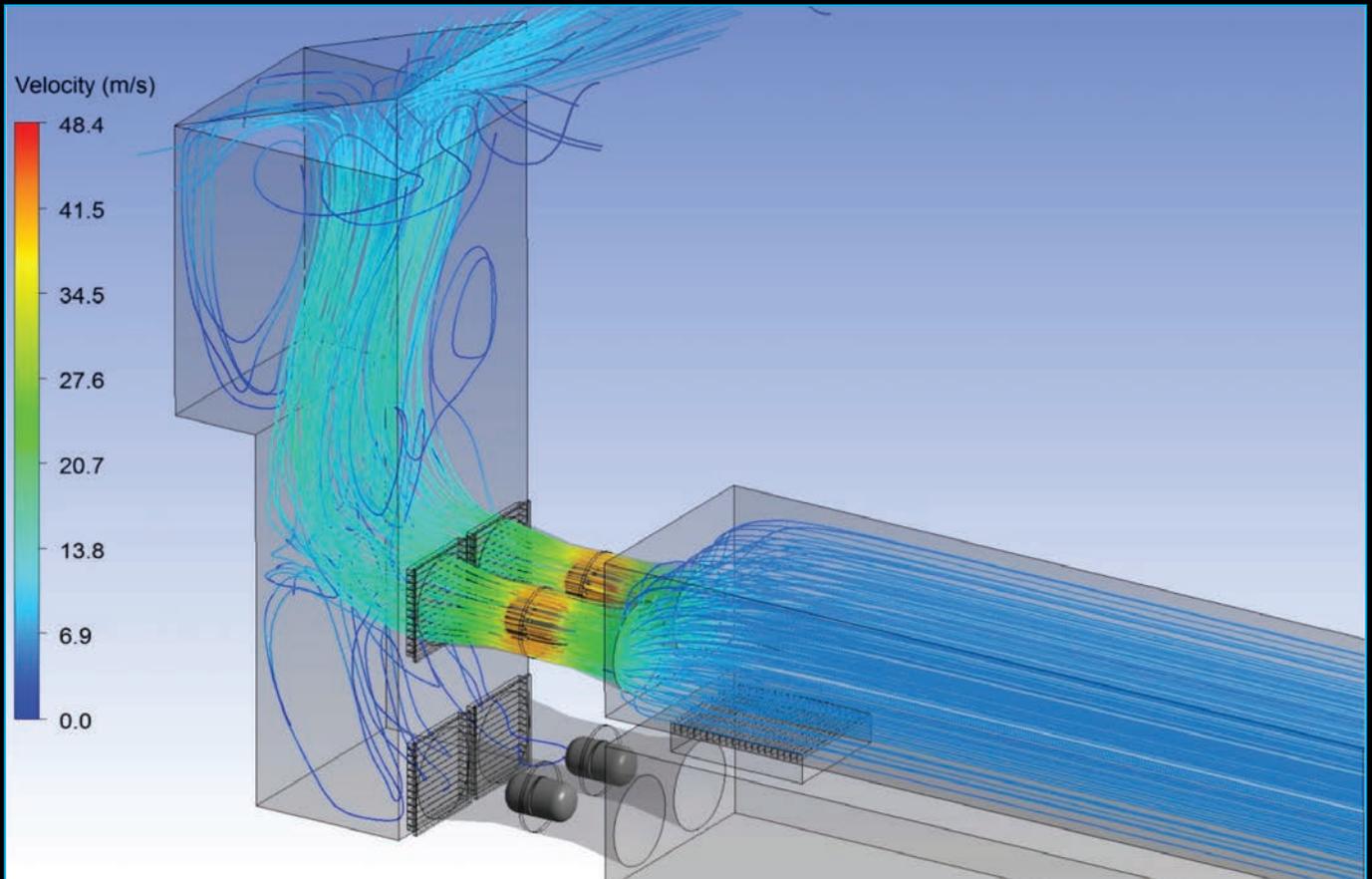
8 JZR jet fans

CFD SIMULATION

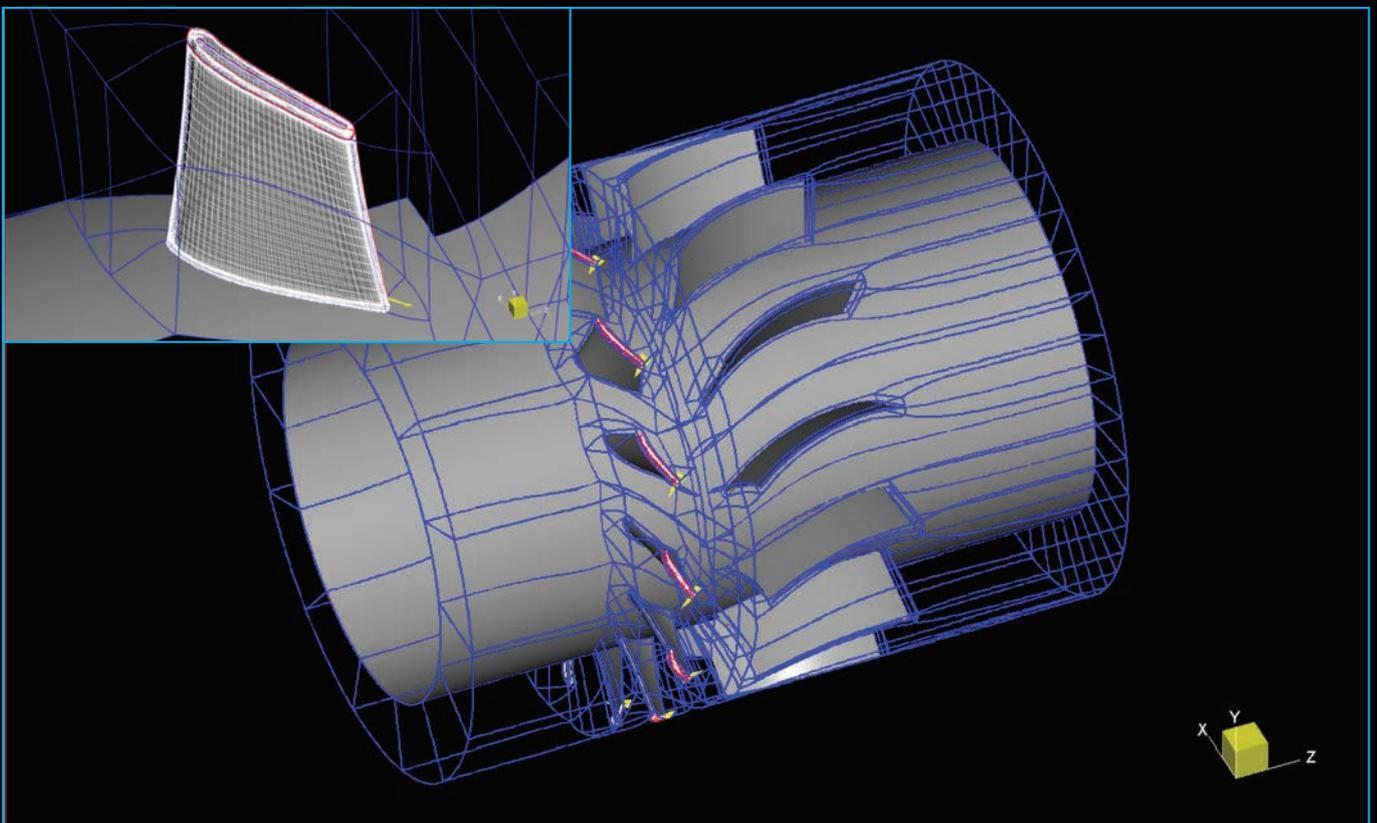
In the early design stages of the project, ZITRON company carried out a Computational Fluid Dynamics (CFD) simulation. This was to optimize the aerodynamic parameters of the fans, taking into account their location in the tunnel, and to optimize the overall energy efficiency of the ventilation system.



Airflow velocity distribution for jet fan ventilation system, cross section



Simulation of air currents in the ventilation shaft of Tunnel 8 – 8a



Modeling flow of the fan section



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