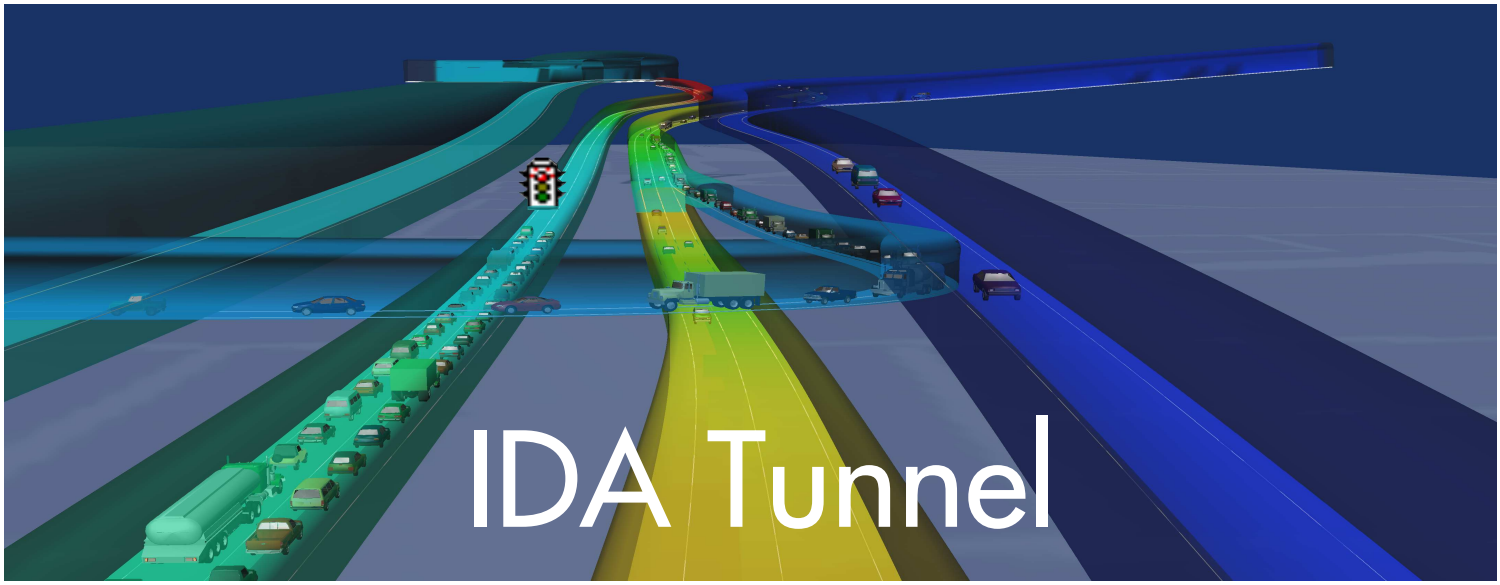


IDA Tunnel

Road and Rail Tunnel Ventilation and Fire Simulation Software

IDA Tunnel is a comprehensive tunnel environment simulation software suite available from EQUA. IDA Road Tunnel Ventilation is the road tunnel subset of the full suite.

Background

In 1995, the design of "Södralänken", a new and modern Swedish road tunnel system, began. This intricate, longitudinally ventilated tunnel network posed challenges that called for new tools. The first version of IDA Road Tunnel Ventilation was developed to address the ventilation and fire design tasks of this project.

A complete re-implementation of the tunnel package in the Modelica language commenced in 2004 and discrete train traffic was introduced in the program. After several full-scale metro modeling projects for Stockholm Transport, the Swedish Rail Authority and the London Underground, the new package of IDA Tunnel was released.

Technical facts: Road

IDA Road Tunnel Ventilation calculates pressure, airflow, temperature as well as CO and NO_x concentrations in complex tunnel networks.

The user enters a geometrical description of the tunnel, i.e. height coordinates and cross-sectional areas along the length of each tunnel branch. Other input data cover ambient conditions, including portal wind pressure, traffic inflow, emission characteristics and coefficients of drag and friction. PIARC and similar emission tables are also included. Tables can be linearly combined and scaled with suitable age, weight and other factors.

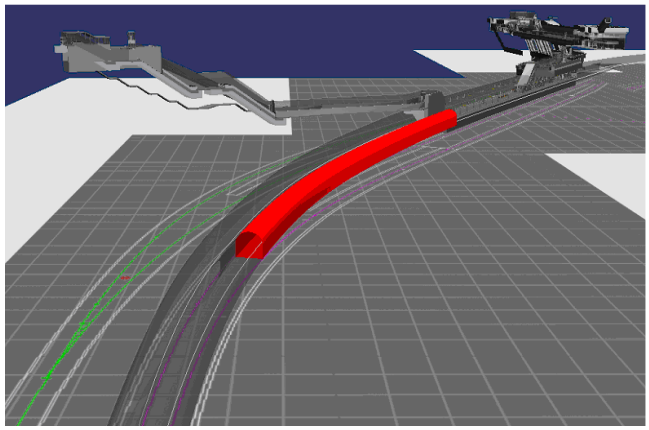
Ventilation may be longitudinal or transversal, with air supply and exhaust terminal devices distributed along the tunnel. For momentum jet fans, the user specifies cross-sectional area, efficiency and air velocity.

Tunnel fire scenarios can be simulated, in which case a user specified heatflux is added in a limited section of the tunnel. Models for smoke production depending on fire type and combustion materials are available as well as fire size limitations according to available oxygen. Temperature profile into the wall and smoke radiation is modeled.

Three road traffic models are available: standing, moving and dynamic. The dynamic traffic model is able to predict many of the phenomena associated with real traffic such as congestion, multi-lane traffic, vehicle and slope dependent maximum speeds.

Technical facts: Rail

IDA Tunnel relies on a truly graphical user interface for definition of the tunnel model. A schematic representation of computational components, such as tunnel sections,



3D tunnel editor

branches, platforms, fans, etc. is accompanied by a 3D

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view, where computed results and moving trains can be animated in the context of a full 3D representation of the tunnel network. (The 3D view is an optional add-in for IDA Road Tunnel Ventilation.)

Train movement under normal traffic and emergency conditions are simulated, based on user-supplied acceleration, retardation, and maximum power and speed parameters. Stochastic traffic patterns may be described to avoid artificial train synchronization effects.

1D air movement driven by train piston effect, buoyancy (stack effect) and wind pressure is modeled assuming air to be weakly compressible, i.e. the tool can predict fire expansion and stack effect but does not deal with pressure waves. This corresponds to the level of approximation of Subway Environment Simulation (SES. Train aerodynamic parameters are identical to those used in SES.

Air moisture is modeled with wall evaporation and condensation. Occupants and explicit sources of water or vapour provide additional sources of moisture. Possible ice and mould build-up is computed.

A radial temperature field of the ground around each tunnel segment is computed and may be superimposed with interfering fields from the ground surface and nearby similar tunnels. Radial water seepage into the tunnel will also affect the resulting temperature field.

Hourly measured climate data may be used. For multi-year temperature predictions, ground thermal properties may be re-scaled with respect to time. This way, only a fraction of historical train movements need to be simulated to arrive at accumulated wall heat.

The following additional air properties are presently computed:

- Age, i.e. total time spent under ground
- Carbon dioxide – mostly generated by occupants
- Particle concentration, e.g. PM10 as generated by train movements. The particle generation mechanisms through mechanical wear are not yet fully understood and further work is needed to validate implemented generation mechanisms
- Optical extinction coefficient of fire and diesel smoke
- CO, NOx and HC, as generated by diesel engines

Contact EQUA for more information and licensing options.

Features and modules

	IDA Road Tunnel Ventilation	+ IDA Control Toolbox	+ IDA 3D Tunnel Editor	IDA Tunnel	+ IDA HIL Console
Bi-directional, multi-lane, dynamically congested road traffic	√			√	
1D prediction of air-flow, pressure, temperature, CO, NO_2, and smoke	√			√	
Fire and critical velocity	√			√	
Longitudinal ventilation with jet fans	√			√	
Transversal ventilation	√			√	
Air-in and -out stations, axial fans	√			√	
Saccardo nozzles	√			√	
Wall temperature profile (heat sink)	√			√	
PIARC emission tables	√			√	
Arbitrarily complex tunnel systems	√			√	
3D plots (value vs. time and path length)	√			√	
80+ feedback control components		√		√	
3D tunnel system editor with traffic lanes			√	√	
3D animation of traffic flows			√	√	
3D animation of computed results			√	√	
3D tunnel system editor with rail lines				√	
Discrete vehicle electric and diesel rail traffic				√	
Variable train headways and stochastic traffic patterns				√	
1D prediction of moisture, CO_2, age of air, HC and PM_{10}				√	
Long-term temperatures, incl. radial water seepage				√	
Tunnel-to-ground and tunnel-to-tunnel thermal coupling				√	
Ice and mould (mildew) build-up				√	
Realistic schedules and measured climate files				√	
Library of HVAC components				√	
Platform passenger comfort (PPD)				√	
Import and SI conversion of SES input files				√	
Hardware-in-the-loop (HIL), real-time console					√
OPC client for PLC communication					√
Operator training simulator toolkit					√

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