Trend Analysis of Long Tunnels Worldwide

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High-speed rail construction projects have frequently required long tunnels to reduce travel time and distance. The California High-Speed Rail Authority (CHSRA) is considering a tunnel as part of a direct route from Palmdale to Burbank that would be up to 16 miles long. With advances in tunneling technology, the many long tunnels in use around the world today hold valuable lessons for CHSR, particularly with respect to minimization of ground disturbance and improved passenger and operator safety. The primary objective of this project is to determine the state of the art for construction and operation of long tunnels.

The long tunnels in use around the world today hold valuable lessons for California's High Speed Rail project – and its tunnel of up to 16 miles being contemplated to connect Palmdale to Burbank.

Study Methods

The research began with a review of the literature on long tunnels around the world, with a focus on their safety characteristics, configuration, and construction methods. The research team constructed a detailed database of information on the projects behind the world's long tunnels. Based on the data, this report presents information on 67 tunnels longer than 4.5 miles, including 32 high-speed railway tunnels, located in 28 countries around the world.

The research team analyzed the data to determine the factors that should be considered in planning long tunnels for HSR projects. Analysis results were documented in a systematic manner to compare with potential tunnels for the Palmdale-to-Burbank segment of the California HSR system.

Findings

The following is a summary of the findings:

- A total of five HSR tunnels of the same length or longer than those proposed for the Palmdale-to-Burbank segment of CHSR have been successfully completed worldwide, and another six are currently under construction or in planning.
- Among the fifteen longest HSR tunnels globally, five are longer than 30 miles and another three are between 20 and 30 miles. This indicates that HSR tunnels longer than 16 miles are considered feasible.
- Worldwide, long high-speed rail tunnels are increasingly designed as double-tube, single-track systems because they are considered safer and better for escape, rescue, maintenance, and operation. Two single-track tunnel configurations connected by cross passages are becoming more popular, mainly due to increasingly demanding safety requirements.
- Approximately 80% of the European HSR tunnels use the double-tube, single-track configuration. However, only 50% of the tunnels in Asia use this configuration, mainly because Japanese HSR tunnels were largely designed for single-tube, double-track configuration.

- Ventilation to control smoke dispersion is also one of the most important systems in a long tunnel. Twin-tube tunnels equipped with cross passages significantly shorten the escape distance, and allow easier access by rescue and firefighting personnel.
- Inclusion of refuge areas in long tunnels is extremely important for safety during emergencies.
- Most long high-speed rail tunnels serve both passenger and freight rail. However, the Abdalajis tunnel in Spain, the Iiyama in Japan, and the CTRL HS1 tunnel in England were designed only for passenger travel.
- Overall, both tunnel boring machines (TBMs) and conventional tunneling methods (drilling and blasting, or sometimes the New Austrian Tunneling Method [NATM]), are popular for HSR and rail tunnel projects. The conventional method was used, at least in part, by 70% of the projects studied, and the TBM method was used, at least in part, by 80%.
- Although TBM showed significantly higher advance rates than conventional tunneling, the conventional tunneling methods have many advantages over mechanized tunneling methods in terrains that feature difficult rocks and highly variable rock conditions, and with projects that have a greater risk of water inflow under high pressure.
- Construction of long tunnels involves dealing with a variety of ground conditions. Many HSR tunnel projects employed a combination of TBM and the NATM.

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Policy Recommendations

A well-developed tunneling strategy can significantly reduce the negative impact of varying ground conditions on construction time. In addition, tunnel excavation spoil management has been recognized as one of the key components in long-tunnel construction.

Based on the research, it is highly recommended that CHSR tunnel projects consider using tunnel segmentation to allow application of different excavation methods depending on geological conditions. In addition, a spoil management policy should be developed before construction to help limit sound, dust, transport, and environmental emissions.

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To Learn More

For more details about the study, download the full report at ***transweb.sjsu.edu/project/1429.html***

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