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Simulation Study on Value of Cable Fire in the Cable Tunnel

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**Abstract**

The cable tunnel fire spreads rapidly, the high-temperature toxic smog accumulates, and the fire fighting is of great difficulties. Once the fire hazard occurs, serious economic losses and casualties will be caused. Through the numerical simulation of the cable tunnel fire process, and the analysis and summary of simulation results, conclusions are drawn of flue gas spread situation and the section temperature changes during the generating process of cable tunnel fires. Then the best fire fighting time is proposed, which provides references for development of fire-fighting measures and selection of the fire protection system.

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*Keywords:* Cable tunnel fire, Accident cause, Flue gas spread and temperature change

**1. Introduction**

With rapid advancing of modernization construction of our country, the application of electrical power in industries is more and more wide, and the safety issues of electrical power transmission are also increasingly prominent. The domestic long-distance power transmission mainly relies on the high-voltage cable tray and cable tunnel, and the cable tunnel is the electrical power transmission mode in cities. However, due to the imperfectness of cable tunnel design and construction in the initial construction stage of China, in the long running, the cable tunnel environment becomes worse gradually, and the loss of the cable itself is aggravated, which leads to reduction in the cable insulation performance, increase in heating value, electric arc formed by local discharge, and other phenomena, causing frequent occurrence of cable tunnel fires. In addition, the cable tunnels are mainly used for cable laying in power stations, substations, large-scale industrial parks and urban electricity major trunk roads. Therefore the fire hazard in the cable tunnel will cause power failure in a large area as well as production halt and other secondary disasters, which brings huge losses to the whole society.

**2. Analysis of accident cause of cable tunnel fire**

The cable tunnels are mainly arranged below the major trunk roads, and most cables are over kilo voltage. Therefore, in accordance with Code for Design of Cables of Electric Work, the flame retardant grade shall be above Grade B, and the flame retardant performance can still be greatly improved. However, even if the flame resistant or flame retardant cables are adopted, effective fire prevention and flame retardant measures must still be adopted. Cause: the flame retardant cable cannot be considered to be of fire-resistant property, which cannot catch fire. Through the flame-retardant treatment, the thermal decomposition and the temperature value of inflammation and spontaneous combustion are improved slightly, but the extent is limited. In addition, to be self-extinguishing does not mean to be non-inflammable, and the cable with

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inflaming retarding and self-extinguishing properties can still burn. The polyvinyl chloride (PVC) contains chlorine, is of hardness, and is able to be self-extinguishing. However, in case of actual fire hazards, PVC can burn at high temperatures. The higher the temperature is, the faster the burning speed is. Therefore, the flame retardant cable does not have the ability to prevent combustion and self-extinguish the flame in any case.

### 3. Simulation analysis of cable tunnel fire

#### 3.1 Model building

The full-size model shall be built in accordance with the data of the cable tunnel in a certain utility tunnel in Shanghai. According to the provisions concerning fire compartment in the tunnel in the building fire codes, the main model of the tunnel which is 2.2m wide, 3.5m high and 200m long is established, and 21,600  $0.18 \times 0.19 \times 0.20$  meshes are divided into; the left side of the model is arranged with the opening, and the right side is arranged with the exhaust blower, forming the wind speed of 1.2m, along the openings in the forward direction of X axis. In accordance with Code for Design of Cables of Electric Work, the fire resisting wall, fireproof sealing, fire retardant bags and other components shall be arranged in each section in the cable fire compartment or every 200m in the ditch. Therefore, the size of openings at both sides shall be the central part of the tunnel  $1.2\text{m} \times 3.5\text{m}$ .

The 0.5m-wide brackets shall be arranged at both ends of the cable tunnel, and the 110kV and 10kV electrical power cable with the flame retardant grade B shall be laid. According to the Code for Design of Cables of Electric Work GB 50217-2007, the spacing between the upper layer and the lower layer of the 10kV bracket shall be set as 0.2m, and the spacing between the upper layer and the lower layer of the 110kV cable shall be set as 0.35m. The cable shall be supported by the tray. The bracket is open to the air flow, and the heat calorie is smaller, and has a minimal impact on cable fire caused by the heat source, which can be ignored in the simulation. The cable material can be simplified to the flat sheet only consisting of fire retardant material outside the cable.

The top of the tunnel shall be arranged with the temperature sensing and smoke sensing detectors respectively. In the model, the smoke sensing fire detectors shall be arranged at 50m, 100m and 150m of the top plate, slices shall be arranged on the cross-section, and the temperature observation shall be conducted.

The model is shown in fig. 1.

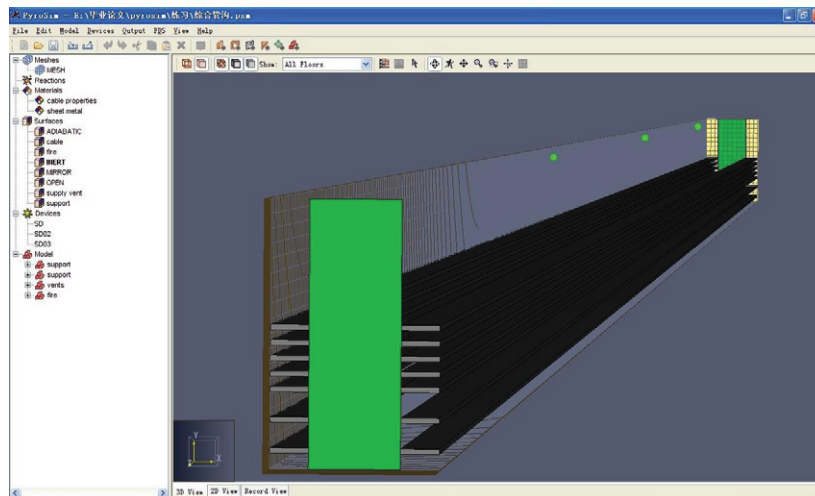


Fig. 1. The model of the cable tunnel

After the model parameters is set up, select the Run option in the software menu, and click Run FDS to conduct simulation calculation to the model. View the flue gas status after the calculation is completed.

#### 3.2 Analysis of flue gas diffusion process

Studies have shown that nearly two-thirds of the death toll caused by fire hazards is caused by flue gas, and the flow direction of the flue gas is the main factor to determine the evacuation style. Therefore, it is of great significance to analyze and research the flue gas spread process.

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