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Evolution of Train Car Ceilings
- Fire Prevention Measures and Ceiling Material –

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In consequence of a fire that occurred at a section of the municipal subway line of Taegu, South Korea in February 2003, measures more stringent than in the past have been introduced in Japan to prevent railroad fires. Concretely, part of interpretation criteria for relevant technical standards has been revised. Regarding train cars, the revision, that began to be applied to newly manufactured cars in January this year, is to effect: (1) the improved fireproofing of compartment ceiling materials; (2) the securing of firebreak sections; (3) the improvement of signs; and (4) the upgrading of equipment for one-man trains. This essay discusses compartment ceiling materials in this context.

○ Requirements for Ceiling Materials

Though various materials are used for train cars, regulation has been tightened only with regard to ceiling materials. This is because the ceiling is of special importance in preventing the spread of fire, in view of the tendency of flame to blaze in an upward direction.

The tightened regulation applies to passenger cars for subway, Shinkansen (bullet train) and other lines, as well as to guide-rail system railroads in case they incorporate underground section(s) and/or long tunnel(s).

Also, the regulation applies not only to the horizontal part of a ceiling, but to its inclined part(s) that may melt and drip while burning; and part of equipment installed on the ceiling.

Desirably, only those materials which are highly resistant to fire should be used for ceilings. Use of materials that may help spread a fire (e.g. those which continue to burn for a while after melting and dripping) should be avoided. The regulation has introduced the following mandatory checks for fireproofing:

(1) Resistance to Melting and Dripping

In the framework of the existing combustibility test of a material for train cars (called the combustibility test), the material's resistance to melting and dripping must be checked. Specifically, the surface of the material must remain smooth after combustion.

Table 1
Reference Values for Judgment on Burning Resistance

Total calorific value [MJ/m^2]	Ignition time [second]	Maximum heat rate [kW/m^2]
8 or less	-	300 or less
More than 8 and 30 or less	60 or more	

(2) Burning Resistance

During a combustibility test using a cone calorimeter (as specified in ISO 5660-1), the reference values for judgment on burning resistance, shown in Table 1, may not be exceeded.

There are no restrictions on testing organization. Results on the above checks, along with other test results, can be controlled using the same test number by making these checks at a testing organization responsible for the conventional combustibility test. As reference values for burning resistance, the equivalent values for semi-incombustible building materials may be used. In such a case, however, ceiling materials must still be subjected to the above-mentioned combustibility test (including a check on resistance to melting and dripping).

○ Activities to Conform to the New Standard

The new standard has already been applied to the manufacture of vehicles. Activities to conform to the standard are described below.

- Ceiling Inside Panel

Various materials are used for ceiling inside panels, depending on ceiling design. Among these materials are melamine laminated aluminum panels and other facing panels; composite panels; and thermohardening FRP. Materials meeting the new standard have already been developed in all these categories. Accordingly, the conventional ceiling design need not be changed in vehicle manufacture. The calorific value for a ceiling inside panel can be minimized through the combined use of a metal material and a facing (e.g. paint).

- Fluorescent Light Cover

A fluorescent light is designed either as a direct or indirect light, or one provided with globes. In consequence of the revision of the standard, the use of direct lights is becoming widespread for commuter trains. Regarding materials for globes, steps commonly taken at present include measures to prevent the scattering of broken pieces, and the adoption of glass that meets the new standard.

- Air Conditioner Air Outlet

Before the revision, extruded resin materials were increasingly used for this part to prevent dew condensation. However, the present choice is between metal or thermohardening FRP.

○ Expectations for Materials

In many cases, it has become necessary to develop and use a new, more fire-resistant material, because a

conventional material does not meet the revised standard. Also, the choice of material manufacturers or molders, as well as that of their products, has become narrower than before due to the need to meet the standard, which has resulted in higher material costs. Therefore, we hope that lower-priced products will be developed in consequence of a future increase in the volume of fireproof materials used. Since the ceiling exerts a high influence on a vehicle's center of gravity, there are some cases in which the use of lighter resin materials is desirable. Accordingly, we also hope that more materials up to the standard will be developed regarding not only FRP, but also milky materials for fluorescent light globes, extruded materials for air outlets etc.

○ Future Task

The revised standard has resulted in the improved combustion resistance of materials for train car ceilings. We as a vehicle manufacturer hope to contribute to improving the safety of ceilings by developing materials that give only small volumes of toxic gas and smoke during combustion, as well as appropriate fireproof barrier designs; and thereby meet the expectations of railway companies.