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To Satisfy a Desire for Relaxation - An Essay on Various Seats -

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○ Train Car and Seats

Among various train facilities, seats have the greatest chances of contacting directly with them. Occupying a large proportion of vehicle space, seats also play a pivotal role in determining the impression of a car in terms of design.

With the evolution of vehicles, the comfortableness of seats has been improved steadily. In Europe, where a culture of chairs has developed throughout its history, techniques for seat manufacture represent a long tradition. Like furniture, vehicle seats were first manufactured using such materials as kapok, palm, horse fur and cow fur felt. In about 1955, cushions using Izumi type net springs were developed. These cushions use coil (casting or cup-shaped) springs, as well as hair locks as padding. This invention helped reduce the weight of a seat and enhance its comfortableness.

Recently, seat design is being improved further through the introduction of human engineering.

○ Introduction of Human Engineering

Human engineering provides a basis for creating more user-friendly machines through scientific research; its aim is to deepen the understanding of human body and mind, and thereby supplement conventional rules of thumb in manufacture. In Japan, former National Railways and other railway companies started research on the improvement of vehicle accommodation. Results of this research have been applied to introducing human engineering-based improvements to seats.

For us humans, a standing posture is the most natural. In this posture, our upper body is free of any stress. A sitting posture causes stress to our pelvis and spine. A chair is an aid to remedy this stress. Human engineering studies on the comfortableness of seats have revealed the following: a comfortable sitting posture is one in which load is borne only by less sensitive parts of a human body. Also, it is desirable to adjust the relationship between pelvis and spine so as to approximate the condition in a standing posture.

○ Design of the Seat Surface for Bearing Body Weight

In a sitting posture, most of the load is borne by the nodular parts of the hipbone. A cushion is used to

distribute the load over a wider area. Comfortableness is influenced significantly by cushion characteristics, including the degree of softness, thickness, and the area in contact with the human body. In view of these factors, the padding for a seat cushion usually features a metal frame with coil springs, on which two layers of cushion material (comprising the soft upper layer and the more solid lower layer) are laid. Finally, the padding is enveloped with muslin and surface covers, then sewn together. This design is aimed at ensuring a soft feel during use; eliminating the impression that you have “bottomed,” as well as the unevenness of the contact area caused by a hard material; adjusting the body pressure distribution appropriately; and reducing the pressure on the thigh back caused by excessive sinking.

Besides satisfactory cushioning, other characteristics are required of a padding, including good breathing, heat diffusion and, in case of vehicle applications, the absorption or mitigation of vibration. Hair locks, a feature of the original Izumi type seat, were a padding that met these conditions. This padding was manufactured as a netted solid by joining pieces of a fibrous material with crude rubber. Though hair locks proved effective in cushioning and the absorption or mitigation of vibration, they have been replaced with resin fibers to achieve a better durability. Incidentally, hair locks using palm fibers, as well as horse fur, are still used for the seats of Benz models.

In the past, urethane foam was mainly used as cushion material. Recently, however, there has been a growing tendency to use polyester-based padding without springs, due to the tightening of combustion gas regulation.

○ Back Padding and Posture

The back padding contacts the pelvis and the spine. If the angle between the cushion and the backrest is small, the padding supports the second to fourth lumbar vertebrae. If the angle is larger, it also supports the lower part of the dorsal vertebra. In case of an extremely large angle, a head support is added to maintain a comfortable posture. Especially, the part that supports the second to fourth lumbar vertebrae (which is called the lumbar support, and generally aimed at the third lumbar vertebra) is important. Recently, some seats, such as reclining seats for Green Cars, feature a zigzag spring installed over the entire back padding, as well as a coil spring installed in the lumbar support. Generally, a lumbar support is made of about 30 mm-thick urethane foam, and is not provided with any springs. An additional, about 10 mm-thick padding is often attached to the surface

of the support to improve the feel.

○ Problems with a Human Engineering-based Approach

Even if a seat has a design that is excellent from the standpoint of human engineering, it may not prove really comfortable for users. In the 1960s, for instance, seats made of FRP, with padded vinyl leather cushions installed on the back and the bottom, were introduced to some subway lines. Though these seats had been touted as comfortable long seats based on results of human engineering studies, they proved unpopular among passengers. The new seats were regarded as deficient in service quality, due to poor cushioning and the lack of style.

Another problem with human engineering is that in the discipline, design is based on human body dimensions. This means that even if the same design procedures are followed, the resulting seat form varies according to which figures are used as indices of the “standard body form.” As a matter of fact, the body forms of passengers are widely different from each other. Also, the types of passengers vary from line to line, and from time to time. In case of straps, the recent tendency is toward providing variations in height to accommodate the difference among passengers in stature. However, it is difficult to take a similar approach in seat design. Therefore, it is necessary to work to create more comfortable seat design by taking the characteristics of particular lines and types of passengers into account, and corroborating results of research through sensory tests (that involve actually sitting on a seat to judge on whether it is comfortable).

It is also important in realizing comfortable design to determine the degree to which a passenger’s posture is restricted by a seat in relation to vibration and shaking during train movement. Seats for a train car don’t need features to protect passengers against rolling, such as bucket seats for automobiles. Rather, they need a degree of latitude that permits passengers to change their posture freely while being seated for a long time. On the other hand, a completely flat bottom or back provides little protection against rolling, which ultimately results in discomfort due to fatigue. Accordingly, features to support a passenger’s body should be designed optimally, to suit such conditions as train line and operation, speed and trip time.

○ Regional Differences in Specifications

Since railroad is a highly localized means of transportation, its specifications vary with country and region. This is true also for seats. For instance, seats made of FRP and vinyl leather are mainly used for U.S.-bound LRV. Seats bound for tropical regions mostly use wood or vinyl leather. Stainless steel seats (without cushions etc.) are manufactured as exports to Hong Kong.

For all these types of seats, the design of basic features (back and bottom angles, the sections of various parts etc.) is based on human engineering. However, details are modified to meet local needs. As a result, they clearly reflect the characteristics of a local region and culture.

○ Seats as the Main Part of Service Facilities

As long as seats will remain the main part of train service facilities, designers will have to incorporate an increasing number of new functions to seats to enhance their comfortableness. The development of new materials and mechanisms will result in the introduction of new methods for posture holding. It is also important to develop body supports for barrier-free movement from or onto a seat; large tables, pockets, hooks, in-arm tables, cup holders and other auxiliary facilities; mechanisms for turning or rotation; and footrests as supportive features of seats. Many tasks still remain to be fulfilled regarding relationship with separate services, measures to prevent accidents and fires, production costs, and equipment weight. The importance of providing seats is growing in our aging and increasingly stressful society. I think that the development of better seats is the single most important task in realizing train designs comfortable for passengers.