Global Expansion of efACE Standard Railcars

Kawasaki's efACE standard cars combine the concept of a standard car and flexibility. In the Japanese market, Kawasaki made full use of this flexibility by expanding the application of the efACE model to both aluminum cars and stainless steel cars.

With an eye to capturing new customers and market share in overseas growth markets, Kawasaki is currently developing standard cars for overseas users based on the existing efACE technologies for the Japanese market.

Introduction

Recently, requests from railway companies (customers) have been diversifying with increasingly shorter delivery schedules and ever lower prices. For this reason, trains had to be standardized and diversifying customer needs had to be met in a flexible way.

1 efACE standard cars

We have been developing environmentally friendly advanced commuter and express train cars known as "efACE" as proposal-based standard cars that meet various user needs.

The efACE standard car is a well-balanced car that anyone can be satisfied with, whether passengers, railway companies in charge of operation and maintenance, or car builders, all of whom evaluate the cars from their own standpoint.

Conventional standard cars that were developed mainly by car builders gave high priority to manufacturing processes and cost reduction, so they were not necessarily satisfactory to users and railway companies.

However, reducing manufacturing costs results in reduced costs for the railway companies purchasing the train, which also benefits passengers as they have more opportunities to ride in comfortable new trains, for example.

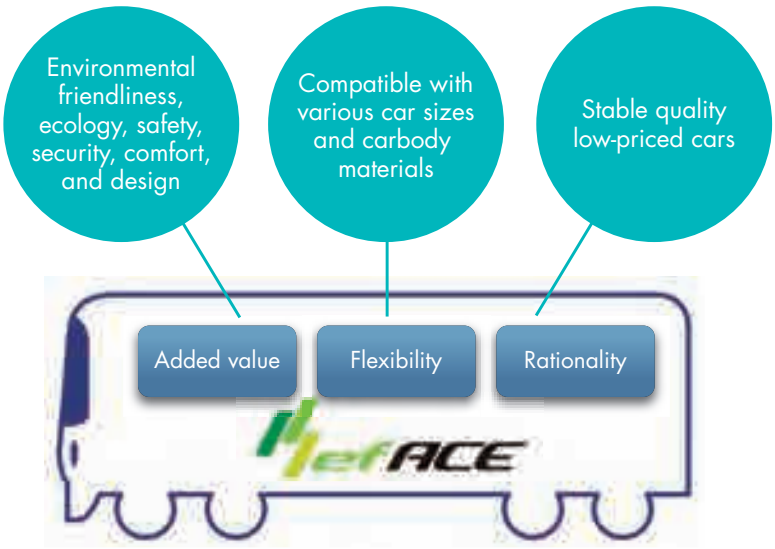

Fig. 1 Basic concepts of efACE standard cars

We have established three basic concepts according to which we produce our efACE cars, namely added value, flexibility, and rationality, in order to maintain the benefits for people in each standpoint even though they are low-priced standardized cars (Fig. 1).

Added value means safety, comfort, and design. Flexibility refers to compatibility with various car sizes, applications, and carbody materials. Rationality represents stable quality, low-priced cars, and so on.

These three basic concepts have often been neglected in the development of standard car by car builders, but these concepts are always given high priority from the planning stage of an efACE car.

This is especially easy to see in terms of "flexibility," one of the basic concepts of efACE. The ability to satisfy various user needs is a given, but efACE goes beyond that with flexibility for car builders. For example, these cars can be made with any carbody material, body structure, and manufacturing method used by car builders. This means that efACE trains can meet user needs that vary from company to company and that affect the basic structure of cars, such as the sizes of cars and side windows, the materials used for the carbody, the locations of doors, and the number of seats.

2 Applications of efACE in the Japanese market

efACE cars were first used for the 3000 Series electric trains for Keihan Electric Railway Co., Ltd. as aluminum commuter trains. After that, the use of efACE trains expanded to stainless steel commuter trains and stainless steel suburban trains by utilizing their flexibility.

Let us introduce some actual cases in which aluminum and stainless steel cars were used.

(1) Aluminum cars

An aluminum car (Fig. 2) is an assembly consisting of underframe, side, roof, and end body structure blocks for which many extruded sections are used.

For the aluminum body structures used in efACE, the cantrails placed at both ends of roof body structures and the side sills located at both longitudinal edges of underframe body structures are flexible parts. That is why

3000 Series used by Keihan Electric Railway Co., Ltd.

16000 Series used by Tokyo Metro Co., Ltd.

Fig. 2 Trains featuring aluminum efACE cars

they are able to meet varying user needs such as different roof heights and car widths (Fig. 3).

A side carbody structure consists of body structure parts with a harmonica shape as shown in Fig. 3. This structure is common to all of our models. The harmonica structure has flexibility that makes it possible to meet various user needs such as different types of car interior equipment and various installation locations without changing side body structure parts.

(2) Stainless steel cars

For a stainless steel car (Fig. 4), stainless steel skins, frames, roll-formed long parts, etc. are assembled by spot welding and/or laser welding to make the underframe, side, roof, and end body structures.

In an efACE stainless steel body structure, the shape of a frame installed onto the side body structure in the longitudinal direction of the car is the same as that of the harmonica structure of the aluminum body structure, making the procedures for installing the interior parts the same for both aluminum and stainless steel body (Fig. 5).

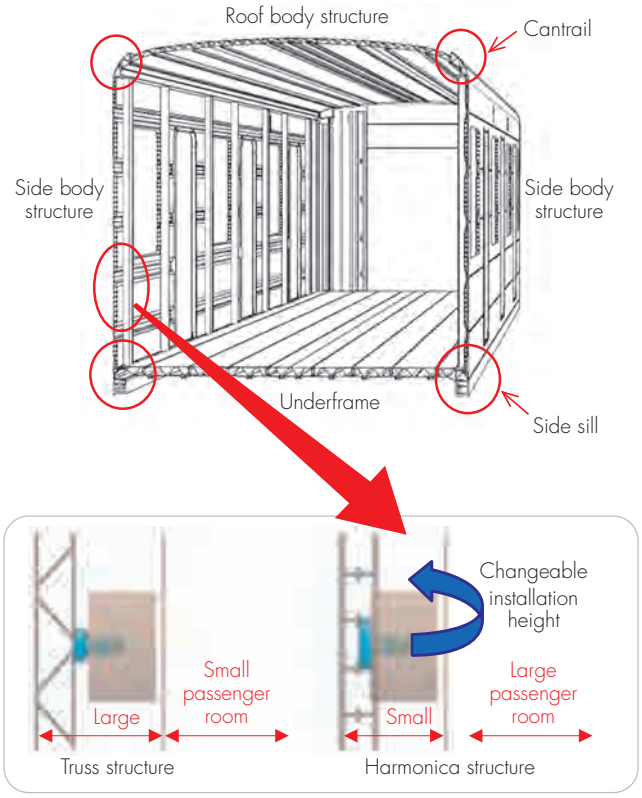

Fig. 3 Cross-sectional structure of an aluminum efACE car

225 Series used by West Japan Railway Company

733 Series used by Hokkaido Railway Company

Fig. 4 Trains featuring stainless steel efACE cars

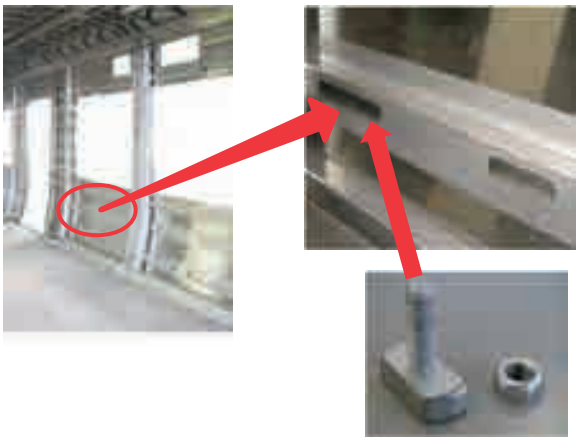

Fig. 5 Interior mounting structure of a stainless steel efACE car

3 Concepts for developing efACE for overseas

When we developed efACE for overseas to satisfy needs, such as the need for increased local production (which has been growing recently), we kept the same three basic concepts while redefining them for overseas as shown below.

Added value ⇒ local production
Flexibility ⇒ flexibility of equipment, procurement, and manufacturing methods
Rationality ⇒ modularization

In addition, the catchphrase
"Anywhere, Anyone"
was announced to allow development team members to share a more specific image of the development concept (Fig. 6).

(1) Anywhere

Various special facilities are required to manufacture cars because of their length. To avoid using such special facilities, cars have to be divided into shorter parts that are then connected, that is to say that cars must be modularized.

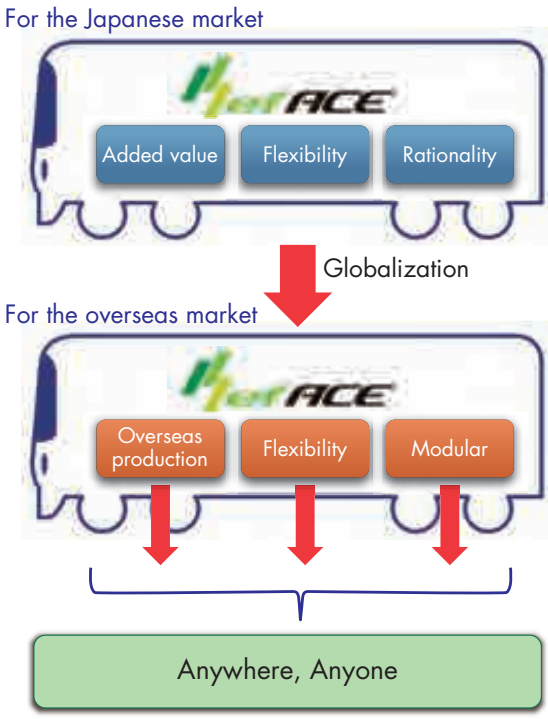

Fig. 6 Development concepts of efACE for overseas

These shorter modularized components can then be procured from new external suppliers instead of existing car builders that specialize in long objects.

In addition, special ground facilities that car builders owned had to be used in the assembly processes for forming the box-shape of the car in the past. We have developed a joining method and special tools that do not require such special ground facilities.

(2) Anyone

Conventional cars were manufactured by relying on the skills of expert engineers such as welders, sheet metal workers, electricians, and plumbers. It is difficult to have local manufacturers and external procurement sources acquire such technical skills in a short period of time. Therefore, new manufacturing methods that do not rely on operators with specialized skills are required.

The sizes of modularized components were determined based on the sizes of the finishing machine tables that ordinary factories owned. Manufacturing processes were mechanized to make it possible to manufacture cars without relying on human skills. In addition, methods for joining components were changed from methods that rely on operators' skills to methods for which tools could be used to perform and manage the joining process.

For wiring work, we only used harness modules to eliminate the work of adjusting the length of wires in the cars and attaching pins to terminals. Because of this, the only work that has to be done in cars is to install the harness modules that were manufactured somewhere else.

(3) Rigging unit

Rigging in car manufacturing refers to installing fixtures, wires, and devices onto cars.

In the standard design process of the past, the car strength, which is a basic requirement of train performance, was given priority and then the design of the rigs was started. In the development of efACE for overseas, rigging is considered from the initial planning stage, including division units between modules of each component and each location.

In the past manufacturing methods, it was not possible to unify division locations, joint methods, and an order of manufacturing processes for the module unit best-suited to rigging and for the module unit best-suited to car strength. Therefore, we changed the manufacturing processes taking the limitations in each manufacturing process into consideration to determine the best module divisions. This made the prefabrication of each module possible.

4 Manufacturing a mockup of efACE for overseas

We manufactured a mockup to verify if the cars that were planned and designed under the above catchphrase could be actually be made (Figs. 7 and 8).

When the module components of each body structure were manufactured, special facilities that car builders own were not used. Only facilities that ordinary sheet metal factories have were used.

When the carbody was assembled, ground facilities

Fig. 7 Exterior of an efACE mockup car for overseas

Fig. 8 Interior of an efACE mockup car for overseas

that car builders owned were not used. We only used the simple special tools that we had designed and developed.

For the interior parts, we freed ourselves from conventional materials for car interiors and we placed orders to new suppliers using architectural materials and resins. Not being bound by conventional methods, we took a hint from the methods for installing appliances used in the construction of stores and we modified them for use in our cars.

In order to verify if the "anyone" part of the catchphrase was true, the persons who had developed and designed this car themselves performed part of the installation in this mockup. This design has eliminated the need for adjustments by skilled workers that were required in conventional work on the interior, so the completed section looks no different from the sections that were manufactured by our skilled workers.

The elemental technologies that we acquired by producing the mockup efACE car for overseas have been gradually fed back into efACE for the Japanese market. The mockup of efACE for overseas for which flexibility was most effectively used showed that the flexibility of efACE for the Japanese market could be further expanded. As a result, we came to be able to accurately and flexibly meet the recent high-level user needs stemming from efforts of companies in the Japanese train market to differentiate themselves from the competition.

Various efACE elemental technologies have been adopted in the new trains we currently are designing.

Conclusion

It was found that our efACE standard cars are highly flexible, in line with the aim of its concept, and that they can also be used overseas.

In addition, we found that the flexibility of the efACE for overseas currently being developed can be expanded further and fed back into projects in Japan along with high-level technologies for conventional trains for overseas.

We will continue to progress in our development to meet the needs of users in Japan and around the world.

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