Product Introduction

KYB Camper Concept

TANAKA Kazunori

Photo 1 Full view of KYB booth at Tokyo Auto Salon 2023

1 Introduction

The core product of the KYB Special Purpose Vehicles Div. is concrete mixer trucks, which have the top share in the domestic market. Concrete mixer trucks are long, heavy vehicles used to transport ready-mixxed concrete. Unfortunately, concrete demand is on a downward trend for the medium-to-long term. The number of concrete mixer trucks owned in Japan is also on a downward trend accordingly.

On the contrary, the demand for camping cars is brisk, mainly among families and senior households. Through the COVID-19 pandemic, camping cars have found a variety of applications: some people enjoy their own personal time, while others use them for remote work. The market has thus enjoyed increasing sales volume. The total accumulated number of camping cars owned in Japan reached 136,000 vehicles in 2021, which is 107% compared to the previous year. The total sales volume has expanded three times from 10 years ago (Figs. 1 & 2, Reference: White Paper on Camping Cars 2021/2022). The recent annual number of newly registered camping cars is 430,000 in the U.S., 230,000 in Europe, 45,000 in

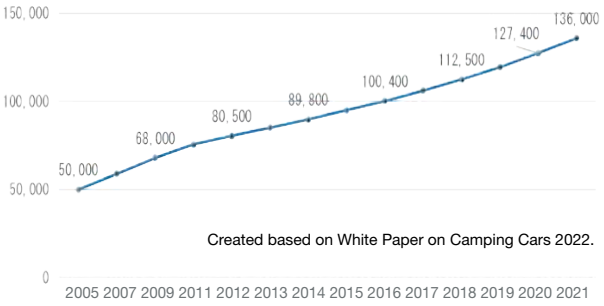

Fig. 1 Accumulated number of camping cars owned in Japan

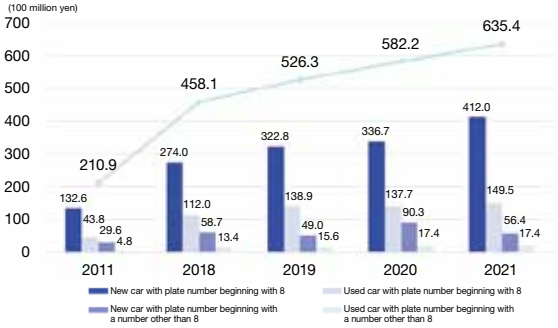

Fig. 2 Domestic sales of camping cars

Australia, and 8,000 in Japan. The number of RV parks and auto campgrounds is 16,000 in the U.S., 11,000 in France, and 300 in Japan. Compared to foreign countries, the Japanese camping car market is relatively small, but has room to grow.

This paper reports one of the attempts by the Special Purpose Vehicles Div. to address another potential market in the course of a study on next-generation products. The Special Purpose Vehicles Div. has little experience in B2C business and has seldom developed commercial products for general consumers. Still, KYB has sought what it can do for the expanding market, including human resource exchanges with other departments and development through cross-functional activities as a company-wide project.

2 Concepts

We had a questionnaire survey for camping car users to figure out what they want camping cars to be and compiled the answers into a matrix of complaints and points that appeal to users (Table 1).

The survey revealed that users of tall camping cars have concerns about driving stability, such as the risk of tipping over due to, for example, wobbling on the highway, crosswinds at tunnel exits or on bridges, or a sloping road with a reverse camber. It was easy to imagine they were not satisfied with the ride comfort. They also complained about the comfort of the vehicle when parked, such as the vehicle tilting during sleep or the vehicle rocking due to passengers' movement. Many of these problems that are related to the vehicle's suspension seem to be able to be solved with our suspension technology. Several comments on the vehicle's convenience were also collected, including the difficulty to find a parking lot, inability to drive on a road with height limitations, and hesitation to use a drive-through. These complaints may be resolved with our vehicle fitting technology.

Table 1 User complaints and appealing points

	Complaint	Scene	Damping force adjustment	Vehicle height adjustment	Suspension lock	Structure
Safety	Wobbling on highways	Highways	•			•
	Being caught by crosswind	At tunnel exits, on bridges, when overtaken by trucks	•			•
	Concern about tipping over	Highway ramps, road surfaces with a reverse camber	•			•
Comfort	Poor ride comfort	Use of tires with a high spring constant, high tire pressure setting	•			
	Rolls and twists	Entering/exiting convenience stores, driving on unpaved uneven roads	•			
	Vehicle tilting	During parking		•		
	Vehicle rocking	During parking (due to passengers' movement)			•	
Convenience	Freely adjustable by user by hand (via smart phone or tablet)		•	•	•	•

Considering the points that appeal to users, we aimed to create a camping car (camper) implementing the following concepts, among various candidate ideas.

[1] A camper for two people, able to smartly move around in tourist spots, driving on narrow roads and using small parking lots in daytime and offering comfortable, relaxing nights when parked at a campground.

[2] A camper for outdoor lovers to enjoy outdoor activities from morning to night, driving on narrow mountain roads, crossing streams, fishing until sundown , and staying inside safe and comfortable even after dark.

[3] A top-quality, high-end camper with which active outdoor lovers can approach nature in a way that they could not experience with a conventional camping car and can even enjoy driving itself.

3 Vehicle Configuration

To implement the appealing points and concepts stated above, we decided against building a camper by van conversion [Note 1)], which is popular in the market but has a lower degree of freedom, preferring instead cab conversion [Note 2)] based on a truck vehicle frame with a cab. Cab conversion was selected because we can make use of our vehicle fitting technology.

To solve the complaints attributable to the vehicle height such as concerns about driving stability and vulnerability to crosswinds, we worked out a hydraulic pop-up mechanism to implement a low center of gravity, low-height vehicle. This mechanism allows users to raise or lower the vehicle height by 600 mm. Setting the vehicle height at a low level during driving enables stable running not affected by wind. Cab conversions from a 1.5 ton small truck with a standard roof can park at major parking lots for regular passenger cars. A prototype we made has driving dimensions of a total length of 4970 mm, a total width of 1850 mm, and a height of 2150 mm and can be parked at any coin-operated parking lot with no particular restrictions, drive-throughs of fast food restaurants, and even underground parking lots with a ceiling height of not less than 2300 mm, making it smart and great for trips . The room height can be 1900 mm with the vehicle expanded so that occupants can stand up and move around comfortably and enjoy cooking with ease.

The vehicle is narrow enough to enable driving on narrow roads in old cities and forest roads along mountain streams without worry. To enable space expansion, a 400 mm slide-out mechanism is provided on the right side of the vehicle, ensuring sufficient room even after installing sleeping accommodation. We made a wooden mockup (Photo 2) to help portray the indoor atmosphere. After experiencing the livability with the mockup, the design process began.

When expanded with the pop-up and slide-out

mechanisms, the cabin space is about twice the capacity during driving (excluding the equipment) (Photos 4 & 5).

Photo 2 Cabin mockup

The world's smallest class micro piston pump (Photo 3) and cartridge valves manufactured by Takako Industries Inc., one of the KYB Group companies, are used to implement smooth hydraulic operation.

Photo 3 Micro piston pump

The cabin may be expanded only in the height direction during a mini break so that passengers can stand up and move around. In places where care about neighboring cars is needed, the driver may choose not to expand the slide-out.

Photo 4 Side face of contracted vehicle during driving

Photo 5 Side face of expanded vehicle during parking

Note 1) Van conversion: A minivan-based conversion in which principally the interior has been stripped out to install camping equipment.

Note 2) Cab conversion: A camping car based on a truck with a cabbed chassis.

4 Manufacturing of Body

The main body of the vehicle fitting consists of a combination of a steel sub frame with sufficient rigidity and sandwich panels made of aluminium and insulating foam. This body is mounted on the chassis to provide a thermally insulated cabin. The pop-up shell and slide-out section also consist of hard shells made of the sandwich panels, delivering sufficient thermal insulation, sound insulation, vehicle security, and a guard against animals during both driving and parking with the vehicle expanded.

For the room expansion functions, we decided to install an electro-hydraulic unit on one side of the chassis frame under the floor to operate three hydraulic cylinders for the pop-up mechanism and one for the slide-out mechanism (Fig. 4).

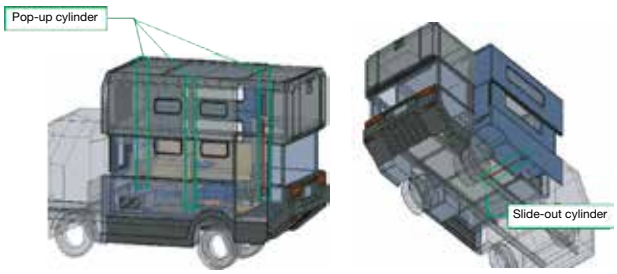

Fig. 4 Cylinder layout

The high-rigidity sub frame contributes not only to easy driving but also to the smooth operation of the pop-up and slide-out mechanisms.

We selected a SUV-like rugged exterior design and installed a rear bumper as seen in passenger cars, emphasizing the departure angle (Photo 6). There is a honeycomb section in the middle part of the rear face to serve as an air outlet of the fan, accentuating the design.

Photo 6 Rear design emphasizing the outdoor characteristics

A water tank is installed in the lower part of the left side to enable water change outside the vehicle. A fuel tank and diesel exhaust fluid tank are located on the right side and can be accessed easily.

5 Installation of Suspension

To improve the running stability, solenoid damping-force adjustable shock absorbers (hereinafter "damping adjustable SAs") have been installed. These adjustable SAs allow the user to adjust the damping force from inside the vehicle, achieving stable, comfortable driving suited to the road surface and running conditions.

In addition, we prototyped a shock absorber with a vehicle height adjustment function that keeps the vehicle level even on a slope and a leveling & suspension lock function that prevents vehicle rocking during being parked (hereinafter "height adjustable SA") (Photo 7).

This paper does not cover the details of the suspension development, which we expect to be introduced in an upcoming issue of the Technical Review.

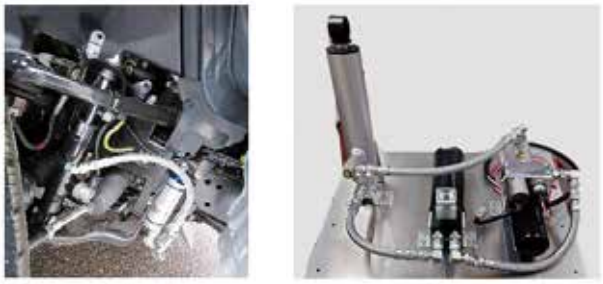

Photo 7 Damping adjustable SA for front wheels, height adjustable SA for rear wheels

6 Interior and Exterior and their Operation

The interior and exterior wrapping was designed by void. Co., Ltd. With the cabin concept of a "shelter" for active people, the interior has been decorated to create a dignified space (atmosphere), giving the camper an upscale image, different to a typical luxury car. While the interior is decorated in classy, chic colors, the exterior is wrapped in earth colors expressing the transition from the ground to the sky in the natural world using contour lines and latitude & longitude lines, to match the "Nature" theme of the exhibition booth (Photo 4, Fig. 5).

A tablet PC or a smartphone can be used to operate the expansion/contraction of the vehicle, adjust the damping force, ensure leveling, operate the suspension lock mechanism, and operate the fan. The application screen has an earth-color based chic design in harmonization with the vehicle design (Fig. 6).

Fig. 5 Interior design

Fig. 6 Smartphone app

7 Requirements for Camping Cars

The newly developed camper comes under the application category of "camping cars" for motor vehicle registration in Japan. The camper should meet the below requirements for the registration as well as related laws and regulations:

- The number of persons sleeping in the camping car shall be not less than 1/3 of the riding capacity.
- The equipment footprint shall be not less than 1/2 of the floor area.
- The storage capacity for clean and waste water shall be not less than 10 L each and tap water shall be readily available.
- Cooking shall be possible with a stove and ventilation shall be available.
- A working surface for food preparation shall be available.

The prototype has a riding capacity of three persons and is equipped with sleeping accommodation that also serves as a living room sofa, a kitchen, clean and waste water storage of up to 20 L each, portable butane stove, a refrigerator, lithium-ion batteries, solar panels, an air-conditioner, and a fan.

8 Exhibition in Tokyo Auto Salon 2023

While the Tokyo Motor Show and other events were canceled due to the COVID-19 pandemic, Tokyo Auto Salon was held to provide a place for automobile manufacturers to announce their new products. With its diversity of exhibits, Tokyo Auto Salon was considered as a good opportunity for us to hear opinions from car lovers. Then, we selected Tokyo Auto Salon as the place

to announce the concept of the KYB camping car (Photo 1).

At Tokyo Auto Salon 2023, we exhibited how a number of project members from various departments worked together to build the car under the theme KAYABA ALL HANDS and used videos to show how we deliver our advanced technology, safety, and security (Fig. 7).

Fig. 7 Image movie

The improved steering stability achieved by the damping adjustable SAs was presented by images and simulation videos. We demonstrated the operation of the hydraulic pop-up & slide-out mechanisms to expand the cabin through a tablet PC and the leveling and suspension lock function (Photo 8). We also demonstrated how to use smartphones to adjust the damping force with the damping adjustable SAs. To demonstrate the effect, we made in advance an actual device that allowed the audience to experience the effect of the suspension by operating a manual lever, highlighting the changes in damping force that might be difficult to recognize in the exhibition booth.

In these ways, we successfully presented the maximum appeal and advancement of the KYB camping car by leveraging our hydraulic and vibration technologies.

9 In Closing

The prototype has been designed as a vehicle for the exhibition and manufactured after much trial and error. We know some engineers may want to give some comments about the prototype. I hope that we will improve and perfect the camping car.

Photo 8 Demonstration at Tokyo Auto Salon 2023

At the Tokyo Auto Salon 2023, our camper gained great popularity among a lot of visitors. We received many comments praising our attempt to develop such a camping car. However, trying to enter a new market as a latecomer will involve various difficulties. We need to consider not only quality but also cost, sales channels, and after-sales service. We will promote product marketing by seeking a style that suits us best.

I would like to thank void.Co.,Ltd. that supervised the exhibition and designed the interior & exterior of the camping car, corporate partners, internal project members, and all those who extended cooperation to the exhibition and interviews.

References

1) White Paper on Camping Cars 2021/2022.

Author

TANAKA Kazunori

Joined the company in 1988.
Engineering Dept., Kumagaya Plant,
Special Purpose Vehicles Div.