



# Journal of Asia Cross Country Rally

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## 1 Introduction

The Asia Cross Country Rally (hereinafter "AXCR") is South East Asia's largest four-/two-wheel rally raid race certified by the International Automobile Federation (FIA) and the International Motorcycling Federation (FIM). Starting from the Kingdom of Thailand, participants drive through its neighboring countries. The 2017 AXCR marked 22 years of history. This is a formal international competition of this kind that is geographically closest to Japan and can be expected for the country to deliver a tremendous advertisement effect in the Asian region. Many Japanese teams with business strategies enter the rally, including those based on Japanese automobile manufacturers or four-wheel drive (4WD) vehicle related companies. Particularly in recent years, AXCR has seen a fierce battle for championships by international cars for emerging countries manufactured by various automobile makers. The participating teams have substantially raised their racing level in their rally vehicles with dramatically improved performance. From Japan, a lot of private teams also participate in the rally probably because AXCR takes place during the summer holiday season in Japan and the costs incurred for participation is reasonable.

The rally course is immensely rich in variety, ranging from labyrinth-like jungle, steep mountainous areas, high-speed gravel-surfaced roads with solid red soil, tarmac winding roads, rocks and mogul sections like trial competitions, to grass tracks including wading. AXCR also features variable road conditions as it takes place in the rainy season. Rainfall may loosen the hard red clay soil to form a slippery mud road surface or change any hollows and mountain streams into sumps or rivers. These conditions may be difficult for even racing vehicles to pass through (Photo 1).

Recent AXCR is arranged to have a total mileage of around 2,000 km and is scheduled so that racers can run on the whole course in six days. The 2017 AXCR had a total mileage of about 2,144 km, of which the road section (hereinafter "RS") was about 972 km and the special stage (hereinafter "SS") about 1,172 km. On the day with the longest mileage of about 420 km, about 250 km was time

attack racing. To compare, this would be like driving from Tokyo to Nagoya on general roads in a day of which the section between Kanagawa and Shizuoka Prefectures is a competition.



Photo 1 Bad road surface due to rainfall

## 2 Position of Cross Country Rallies

Motorsports of four-wheel cars can be roughly classified into three types: racing, rallying and trials.

Racing is a competition where multiple motor vehicles run simultaneously on a closed course such as a circuit to compete with each other. The most famous being the top-ranked Formula 1 (F1).

Rallying consists of the RS rallying that racers have to accurately drive each segment of a course in a specified time and the SS rallying that racers compete against the time of running over a specified section of a course. In either type, each team starts the rally at fixed intervals. Multiple RS and SS rallies are usually set and the RS penalty time is added to the SS running time to determine rankings. Rallying also features two contestants: a driver and co-driver who navigates. The famous rallies include the World Rally Championship (WRC) and the Dakar Rally.

Trials refer to time trials in which each vehicle runs on a specified section of a course to finish as quickly and accurately as possible. Examples of these trials include

Gymkhana, Dirt Trial and Drag Racing.

In addition, many other motorsport activities exist: Eco Run to struggle for fuel efficiency and drift championship for competition with vehicle position and speed during drifting.

Rallying can be divided into two types: Sprint Rally, typified by the WRC (Photo 2) and Rally Raid, typified by the Dakar Rally (Photo 3). A major difference between the two is that Sprint Rally has a pre-run process called reconnaissance or recce that allows drivers to run on the stages of the course before competition and create their own pace notes on the course information, based on which they tackle the time attack racing. In either type teams run on a specified section to compete with each other for the running time over the section based on the distance information, as well as branch and obstacle information indicated on competition maps called "route notes" (Photo 4) supplied by the organizer.



Photo 2 Sprint Rally (Japanese Rally Championship)



Photo 3 Rally Raid (AXCR)

For Rally Raid in turn, the target stages of the course for both RS and SS are not allowed to be scanned prior to race. Drivers have to compete with each other on the stages they run for the first time. In this way Rally Raid requires them to always try to identify the proper course by using the route notes during SS time attack racing. For complex routes with a high degree of difficulty, it is quite difficult to completely avoid time lost due to course error

29			30		
25.19	0.15	KLN-NARROW	25.77	0.13	NARROW TREES
25.29	0.10	NARROW T/F	25.91	0.14	VERY NARROW T/F
25.40	0.11	K-L, SMALL SPIRIT HOUSE ON R	26.03	0.12	FMT
25.52	0.12	FMT - MANY BENDS	27.39	1.36	T-L SAND TRACK
25.64	0.12	MANY BENDS FMT	27.59	0.20	RUTS 4M T/R
					NARROW NEXT MANY BENDS
					MIND TREES AND STUMPS

Photo 4 Route notes

or a penalty time charged by not-passing a check point, greatly affecting the running time.

Another difference is that Sprint Rally is conducted on properly maintained general or forest roads while Rally Raid is more like an adventurous endurance race in which drivers rather run a long distance off-road course under natural conditions.

Furthermore, Sprint Rally racers can improve their driving accuracy by accumulating experiences on the same course as they run over and over again without changing their camp location where the operation headquarters are established. For Rally Raid, they relocate their camp almost every day to move ahead toward the destination. Competitors repeat their great movement over several days and almost never run on the same course.

Drivers running on their first-ever course need to instantly determine the situation from their own driving feel & empirical value, actual visual information and navigational information provided by their co-driver, and must be adaptable to properly control the vehicle and drive faster. Co-drivers must be able to identify where they are by reading the route notes, give the driver proper route instructions, control the rally progress time of their own vehicle, obtain and develop the latest information about the general rally progress provided by the organizer, and manage the driver's mental control. Co-drivers are thus required to have management skills in addition to navigation capability. During competition, the driver and co-driver have to overcome many different difficulties, including accidents and troubles through teamwork, trying to finish the rally. The relationship of trust between the two parties is very important and substantially affects the rally result.

### 3 Trend of Dampers for Rally Raid

Among international rally raids, AXCR has a relatively short total mileage, thereby imposing a lighter burden to racing vehicles. These vehicles are invested with less money for manufacturing accordingly and likely to be

finished by modifying limited parts. Therefore the suspension finishing substantially affects the rally results in many cases. AXCR may be a rally highly dependent on the damper performance.

Basically, participating teams can freely select damper modifications within a specified range, for example, changing the installation position, installing additional dampers and extending the damper length, although there are some limitations on usable dampers according to the regulations related to entry into each rally raid. Furthermore, the teams are allowed to almost freely determine the installation of a damping force control or vehicle level adjuster, the addition of a separate reservoir, provision of other additional functions as well as the material, size and form of dampers. The damper specifications can be set with a high degree of freedom (Photo 5).

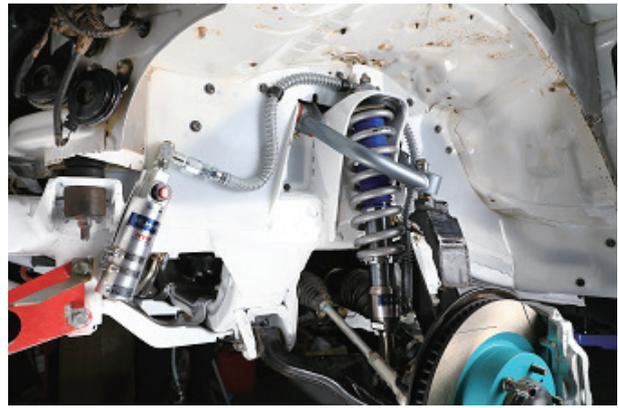
Noticeable prohibitions include electronic or mechanical devices that allow competitors to voluntarily change the damping force or vehicle level during racing.



**Photo 5** 2017 AXCR Spec. damper for Team-JAOS

For off-road driving, the most effective means to ensure that racing vehicles can run through a whole bad road course is to extend the suspension stroke. The current predominant dampers are designed to have a long stroke by taking into account the angle of oscillation of the drive shaft and flexibility of the suspension link. In addition, many vehicles use a double damper setup with sub dampers added (twin shock type) for higher damper reliability against the input from the road surface during the rally as well as for additional damper functions. However, this double damper setup involves constraints related to possible interference with the suspension arm since the setup is installed in limited space within the tire house. On the other hand, a single damper setup (single shock type) only involves low limitation on the interference (Photo 6). It has advantages of lower damper cost, lower weight, fabrication in shorter time at lower cost, simpler maintenance, and lower number of spare parts to be carried.

The use of wide tread arms of a length different from the genuine product is possible depending on the modification regulations related to the entry. With these arms, some vehicles have a damper setup to substantially extend



**Photo 6** Single shock type (front suspension for Team-JAOS)

the suspension stroke so that the maximum possible stroke for the wheel shaft can be attained within the specifications. This configuration can achieve a certain long tire stroke that cannot be implemented with the genuine arm, providing a great advantage of improved running on bad roads.

There are various ideas about damping force characteristics. It may be useful to take measures for two separate damping zones: a regular bad road zone for ordinary off-road running and a full bump zone involving jumping & landing in relation to large hollows. In regular bad road zones, importance is placed on the adhesion of tires and a low damping force is preferred. In full bump zones, a high damping force is needed. These are tradeoffs of damping forces during off-road running. Normal dampers have a speed-dependency structure and cannot resolve the tradeoffs. The two factors only have to be compromised with an aim of striking a balance between the two as far as possible, resulting in compromised damping force characteristics.

One of the recent potential solutions is to replace the rubber or urethane cushions installed between the vehicle body and suspension arms with hydraulic or pneumatic position-dependency damping force mechanisms that can alleviate only the input during full bump, although it depends on the regulations. In this case, the conventional speed-dependency damper structure remains to still ensure the characteristics suitable for the regular bad road zone. This solution resolves the tradeoffs stated above.

In terms of strength, it is difficult to find durability-oriented specifications similar to the damper design for mass-produced vehicles. Therefore, a robust design is preferred in which the worst possible input case during the actual rally and safety margin have been taken into account. The dampers can hardly be changed with new ones within the competition section in the same way that flat tires are changed. If the vehicle cannot reach any service point for repair, it may have to retire from the rally. A breakage of dampers that would immobilize the vehicle is not acceptable, so robustness takes precedence over weight. The resultant damper design is a large

damper, like those for trucks that have large outside diameters as well as large rod diameters.

The heat generated during running on long-distance bad roads decreases the damping force, leading to inferior steering performance and stability of the vehicle. The upsized dampers need more damper oil and installation of separate reservoir leads to measures against the generated heat, using even more oil. A large aluminum reservoir equipped with a radiating fin is introduced in some cases, with an expectation for a cooling effect from the wind during running (Photo 7).



**Photo 7** Large aluminum reservoir

The rally raid damper market has products from many countries. Particularly, U.S. damper manufacturers introduce a lot of products to the market. The reason behind this fact is that off-road or desert races typified by Baja 1000 are brisk in the U.S. Off-road race goods, including customized parts are commercially viable to form an after-sales part market in the country.

#### 4 Participating in AXCR

KYB supports a rally team named "Team-JAOS", mainly consisting of JAOS, a Japanese general 4WD after-sales parts manufacturer. The team had participated in AXCR as part of its forerunner "RV Park with JAOS" for two successive years since 2004. In 2015, JAOS eventually established its own independent team as a project to celebrate its 30th founding anniversary.

KYB's relationship with JAOS originated in around 1998 when KYB started to supply damper products for 4WD vehicles to be introduced into the customization market. KYB began supporting rally activities when JAOS participated in AXCR in 2004. This is its third year of participation in AXCR as an independent team. I have continuously provided technical support since its establishment.

##### 4.1 2015 AXCR

In the 2015 AXCR when the team was established, I was given an opportunity to accompany the team to the site as both a damper engineer and mechanic. I was

selected as a supplementary member to strengthen the foundation upon establishment of the team since my capability of designing/developing dampers and my experience in on-site technical support for the leading teams participating in the Dakar Rally were recognized.

In addition to being a supportive damper engineer, I was assigned with an important role as mechanic or team crew. That was a valuable experience I had never had before.

The general daily schedule started with a final inspection of the rally car in the morning, watching the start with my own eyes, arriving ahead at the merging area in the afternoon to carry out minor maintenance called remote service, and arriving ahead again at the camp in the evening to do major maintenance service for the next day (Photo 8) until midnight. This flow of activities is repeated every day during the competition period. I was required to do speedy, accurate work for days on end in outdoor sites with poor equipment under a higher-temperature, higher-humidity environment than in Japan. Particularly, the afternoon remote service was busy and the maximum maintenance menu had to be completed in a limited time as short as around five minutes. The maintenance menu included temporary repair of broken parts, inspection and oiling of applicable parts, wiping of windshield glass and number decals, and replenishment of drinking water and food. These tasks should be promptly prioritized and assigned to mechanics so that they can quickly complete their own work menu. I directly felt a one-of-a-kind atmosphere with much excitement and strain. The sense of finished work in securely sending off the car was a privilege that could be experienced only by mechanics.



**Photo 8** Mechanics doing service work until midnight

I remember an impressive day on which a machine problem could not be smoothly resolved and mechanics continued working in the rain until midnight without taking dinner. Under the depressive atmosphere, a manager-ranked member brought us hot sandwiches and Coca-Cola bought in a convenience store as provisions. I felt the food most delicious during the competition period.

The rally car was a Toyota FJ Cruiser, modified from a demonstration car owned by JAOS. With its wide body of a width of about 1.9 m, the vehicle was actually difficult to steer in the jungle, but quite reliable as it showed pow-

erful running with a gasoline engine of large displacement (Photo 9) in steep mountainous areas.



**Photo 9** First entry as Team-JAOS

#### 4.2 2016 AXCR

In the 2016 AXCR, I was assigned to be team manager based on the previous years' experience as an on-site supporter, in addition to damper engineer & mechanic as before. The mission of team manager varied from determining the service crew activity schedule, identifying the maintenance points of the rally car, controlling the spare parts, procuring food and beverages, to money control. I strongly remember that I ran around here and there all the time while getting involved in damper or vehicle maintenance so that mechanics could focus on working stress-free. Partly because I was short of sleep, which was even worse than in the 2015 rally, I came back to my room and lay down on the bed to just take a rest for a while after a prize-giving ceremony party, but I fell asleep there. I eventually missed the following celebration party of the team. This is a still regrettable memory.

I was also impressed by border crossing from Thailand to Cambodia during movement in the competition. I left Thailand with departure processing and then walked about 50 meters to cross the border (Photo 10). Then I completed my entry formalities to Cambodia. The cross border walk was wonderful for me as a Japanese who



**Photo 10** Border on the Thailand side

lives in an island nation. I did not know why, but local people freely crossed the border without any processing, which was also strange to me.

For this rally, a new model of Toyota HILUX REVO, which had not yet been introduced to Japan at that time, was directly imported and finished as a rally vehicle in a short period. This tough vehicle with a ladder frame structure and high-rigidity chassis ran the whole distance without failure in spite of minimum reinforcement (Photo 11). The vehicle was modified in its many parts even during the short time. For example, the long body of a total length of about 5.3m was converted into a short deck for easier steering on the narrow rally field. The rear suspension was also relocated. The knowhow accumulated in this modification was put into use in the vehicle modification for the following 2017 AXCR. 2016 was the year in which we acquired important data.



**Photo 11** 2nd year with a stronger tie between JAOS and KYB

#### 4.3 2017 AXCR

In the following 2017 AXCR, the collaboration between JAOS and KYB was further strengthened. As my technical support and on-site accompanying as a team member in the past two years' competitions were recognized, I was assigned with the leading role as a co-driver in addition to damper engineer. Against the package-type damper specifications in the previous two years that were based on the product concept for general customers, the objective in the 2017 AXCR was to pave the way for the development of a high-performance damper comparable to those made by leading overseas damper manufacturers.

An aim behind the objective was to evaluate a damper designed by an engineer in the actual rally himself by driving the actual vehicle and to directly feedback to Manufacturing. This was a very valuable opportunity for me, as an employed engineer. I spent a quite busy year playing both roles as a damper engineer and a competitor. I strove not only to design and manufacture a new high-performance damper but also to obtain a competition license, take training as a co-driver and improve my physical prowess. I did not forget spending with my family to compensate my absence from home during the

summer holidays as in the previous years. Thus I prepared for the rally as much as possible in both my public and private life.

All events during the competition were fresh and exciting to me, although I was nervous or confused in many scenes. It was also true that I spent hard days getting a harsh lesson on the rally raid almost every day (Photo 12). The rally environment was severer than I imagined. For example, the route setup was so difficult and more complicated than in previous years that even an experienced co-driver could miss the course. I also had to handle emergency repair of sporadic vehicle problems, heatstroke due to high temperatures, and fatigue from long-distance/time SSs. I felt acutely anew that a rally raid is a survivor rally for human beings and that a contestant needs to have not only experience, judgement, physical fitness, mental power, but also a wild hunch.



**Photo 12** The author in the car as co-driver

The dampers endured the running over the total distance of about 2,000 km over six days under various adverse road conditions free from trouble or need for maintenance, demonstrating their strength, rigidity and endurance. In terms of characteristics, I fully experienced the strong and weak points myself and consequently obtained many hints for future improvement. In particular, the actual rally track was found to be different in many points from the trial track used during the development stage. Selecting a highly reproducible road surface will smoothly promote the development in my opinion. I was also convinced that any items to be improved should be addressed with the whole vehicle, not only with the dampers.

A simple idea of ensuring that rally cars can run faster, which is in fact common to all motorsports cars, is how long the driver can depress the accelerator. In rally raid races, it is ideal to run the whole course with no need for deceleration, as if there is nothing wrong no matter how irregular the road surface is.

Like the 2016 race, our team took part in the 2017 AXCR with a Toyota HILUX REVO. Based on the result in the previous year, the vehicle was improved in many areas, including a substantial change in arrangement of the rear suspensions. Despite being a hard race equivalent

to, or even harder than the previous year, the vehicle had no obvious trouble, proving its toughness. The colored skeleton graphic body (Photo 13) was something new.



**Photo 13** Colored skeleton graphic body

## 5 Automobile Situation and Rally Raid in Thailand

Thailand is an important country for Japanese manufacturers to establish overseas production sites. This is also the case with automobile related companies, including KYB. Like the base vehicle of the rally car used in the AXCR races, a number of locally produced cars run in the cities. It is also certain that cars imported from Japan are popular in Thailand. The proportion of Japanese cars throughout the country is quite high according to my impression.

Among these, pickup trucks, which are seldom seen in Japan, are rather popular in Thailand. They seem to be selected by Thais as general passenger cars, a method of transportation that can carry many people and cargo and run even on unpaved roads, although this may vary by city. Pickups are used, not only as regular trucks, but also as taxis or even police cars (Photo 14). For AXCR as well, many pickups are selected as racing cars probably because of advertisement strategies of automobile makers with a focus on the local market.

I had a lot of opportunities to visit local cities and rural villages in Thailand in supporting the rally. I had the



**Photo 14** Police car (left) and taxi (right)

impression that roads in these areas are unpaved but maintained quite well, and the road improvement covers even deep in the mountains. I saw highway construction work in many places all over the nation, including towns and mountain villages. As I have heard that countries with a higher standard of road infrastructure development have a higher economic growth rate, Thailand seems to have achieved a steady economic growth.

The highway network development allows people to come and go actively, even in remote areas. In the SS rally section, I passed by several villagers riding on scooters in spite of being in a mountain area far from town (Photo 15). I also had the impression that the number of routes suitable for racing has unfortunately decreased inside Thailand when I considered safety during competition and the adventure characteristics of the rally raid. As more and more roads are improved, however, sprint rallies, instead of rally raids, may become popular in future in the country.



**Photo 15** Local children coming to watch the rally

## 6 In Closing

Many people both inside and outside KYB extended cooperation and support to me in participating in the 2017 AXCR as a co-driver. I successfully entered the competition and finished the course in the end (Photo 16).

On this occasion, I would like to deeply thank all those concerned.



**Photo 16** The team that finished 2017 AXCR (author on the right)

## Author



### TANAKA Kazuhiro

Joined the company in 2001.  
Design Sect. No.3, Engineering  
Dept., Suspension Headquarters,  
Automotive Components Operations.  
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