

## Off-Road Vehicles in India

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**Abstract:** my paper is highlighting Off-Road capability of vehicle in India, There are lots road network connecting India. But lots of adventure peoples love to drive vehicles everyday for climbing of mountain, Go for rides, Etc so Off-Road capability vehicles are very important a review paper is highlight Off-Road vehicle in India. There are some good quality of vehicle in India give the capability to drive on Off-Road my paper is highlighting on the brand of Off-Road vehicle which is superior at the particular area and climate, also highlighting history and geography Off-Road, Upcoming Off-Road vehicle in India, Design and implementation of Off-Road, Engine capability.

Based on this points any one can understand & select the vehicle Off-Road vehicles as per requirements, Off-Road vehicles in India are also used as commercial vehicle which depends upon the application of passenger who are interested to buy and go for off road vehicle. These vehicles are best as compared to ordinary car. Some quality of people refer people this vehicle based on design the chassis frame model based design used for higher strength also BIW used in some vehicle aesthetic look of vehicles, In Off-Road vehicle ground clearance is more with better suspensions outcomes. Large size in tire is fitted in vehicle for ruggedness of vehicle we feel better when we drive; it is like having wonderful experience of Off-Road adventure. Off-Road vehicle in worldwide have many applications include cold climate operating vehicles, Army operations as a truck, Etc. Paper is highlighting fact for Off-Road capability of India.

**Key words:** Off-Road, Design, Highlighting, Engine capability, chassis, Aesthetic.

## 1. Introduction

An off-road vehicle is considered to be any type of vehicle which is capable of driving on and off paved or gravel surface. It is generally characterized by having large tires with deep, open treads, a flexible suspension, or even caterpillar tracks. Other vehicles that do not travel public streets or highways are generally termed off-highway vehicles, including tractors, forklifts, cranes, backhoes, bulldozers, and golf carts.

Off-road vehicles have an enthusiastic following because of their versatility. Several types of motorsports involve racing off-road vehicles. The most common use of these vehicles is for sight seeing in areas distant from pavement. The use of higher clearance and higher traction vehicles enables access on trails and forest roads that have rough and low traction surfaces.



Fig1: Off-Road Vehicles

## 2. History & Review of Off-Road vehicle in India

In 1897, the first car ran on an Indian road. Through the 1930s, cars were imports only, and in small numbers, an embryonic automotive industry emerged in India in the 1940s. Hindustan Motors was launched in 1942, long-time competitor Premier in 1944, building Chrysler, Dodge, and Fiat products respectively. Mahindra & Mahindra was established by two brothers in 1945, and began assembly of Jeep CJ-3A utility vehicles. Following independence in 1947, the Government of India and the private sector launched efforts to create an automotive-component manufacturing industry to supply to the automobile industry. In 1953, an import substitution program was launched, and the import of fully built-up cars began to be restricted.

One of the first modified off-road vehicles was the Kégresse track, a conversion undertaken first by Adolphe Kégresse, who designed the original while working for Czar Nicholas II of Russia between 1906 and 1916. The system uses an unusual caterpillar track which has a flexible belt rather than interlocking metal segments. It can be fitted to a conventional car or truck to turn it into a half-track suitable for use over rough or soft ground.

From the 1960s and onward, more comfortable vehicles were produced. For several years they were popular with rural buyers due to their off-road and load-lugging capabilities. The U.S. Jeep Wagoneer and the Ford Bronco, the British Range Rover, and the station wagon-bodied Japanese Toyota Land Cruiser, Nissan Patrol and Suzuki Lj's series were all essentially just station wagon bodies on light truck frames with four-wheel-drive drivetrains. Later, during the 1990s, manufacturers started to add even more luxuries to bring those off-road vehicles on par with regular cars. This eventually evolved into what we call the SUV today. It also evolved into the newer crossover vehicle, where utility and off-road capability was sacrificed for better on-road handling and luxury.

At present in India there is lots of company which are making off road vehicles with best better quality under affordable price with concept of make in India. Now India company develop and manufacturing best quality as compared to foreigners company.

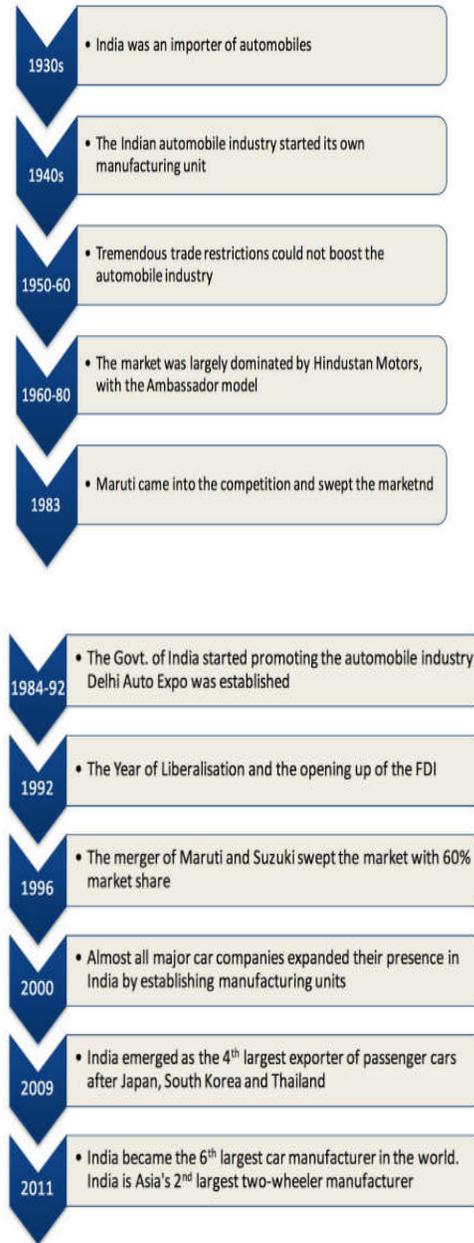


Fig2: Historical & Background Off-Road vehicle

### 2.1 Motor Liberalization

We started from a phase where there were few options with automobiles. This phase continued for an extended period until the phase of the liberalisation. It encouraged

many international players to foray into Indian markets. Many of them collaborated with the local manufacturers to form companies to capture markets as per the needs of local customers.

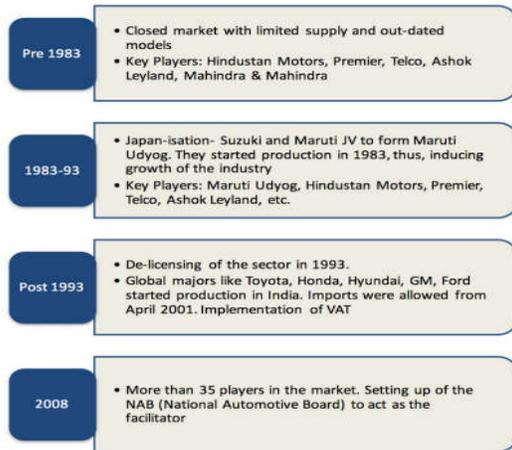


Fig3: Motor Liberalization in India.

### 3. Off-Road vehicle in Indian

The automobile sector in India has mushroomed over the years into a mature and well established industry. The establishment of a 300 million middle class in the last twenty years has helped the industry to grow into a profitable venture which sells over 100,000 passenger vehicles per month in the country and produced over 2.6 million Indian automobiles in 2009. India is also the fourth largest automobile exporter in Asia. It is estimated that by 2050 there will

be more than 600 million cars on Indian roads.



Fig4: Automobile Manufacturing Companies.

### 3.1 Off-Road Manufacture in India 2020 list of some best Off-Road cars in India

- ISUZU D-MAX V-CROSS



Fig5: Photo isuzu D-max V-cross

Though many pickups were sold in India over the years, only the Isuzu DMax V-Cross managed to attain the title – lifestyle pickup truck. Thanks to its large dimensions, the Isuzu has got an unmatched road presence. While Isuzu India also sells models such as the MU-7

and the MUX, the DMax has been their trump card ever since its launch in 2016. The pickup has also received an update in 2018 which mainly included subtle cosmetic changes. Giving justice to its 'lifestyle pickup', the DMax is well- the inside and also gives a comfortable riding experience. There is also a host of customisation opportunities for the pickup; both factory and aftermarket. Some have also started to unleash its true potential in off-road motorsport events.

- **MAHINDRA BOLERO**



Fig6: Bolero top model

The Mahindra Bolero is a rugged SUV. While material quality, fit and finish etc. are not the strong sides of the Bolero, the SUV has got a go-anywhere capability. The vehicle features ample amounts of space inside while also providing all the basic features you would expect. The Bolero is preferred by many who live in the ghat sections and hill stations, while

some who have large acres of land use the SUV to transport goods and people. The Mahindra Bolero is also used for commercial purposes (pickup format) and even in emergency services (police vehicles, ambulances and the fire department).

- **JEEP COMPASS**



Fig7: Jeep compass 1.4 Sport Plus

Jeep Compass is an entry level model in India from the brand's line-up. However, the Compass is more than capable of handling off-road terrain. The capabilities of tackling rough terrain is further improved in the Trailhawk variant of the Compass SUV. The Jeep Compass Trailhawk also comes with trail rated badge indicating different off-road capabilities of the SUV. This includes water fording, suspension articulation, maneuverability, ground clearance and traction

- **FORD ENDEAVOUR**



Fig8: Ford Endeavour

The Ford Endeavour one among the two most popular premium SUVs on the market today. Sold as the Everest in global markets, the Endeavour comes with two diesel engine options: a 2.2-litre four-cylinder and a 3.2-litre five-cylinder. The seven-seater comes only with an automatic transmission; a really good one. But what interests everyone is the looks of the Endeavour. The Ford SUV has got immense road presence, thanks to its bold styling and large dimensions. The overall fit-and-finish is also really good in typical Ford fashion. The Endeavour comes with a host of driving aids/assists which makes the SUV, an easy vehicle to live with. As for its off-Roading capacity, the high ground clearance and massive wheels can take over most Indian terrains.

- **JEEP WRANGLER**



Fig9: Jeep Wrangler

Jeep Wrangler has been on sale for many years. Jeep has updated the off-road SUV and made it more refined and comfortable, retaining its rugged off-road capabilities. The Wrangler off-road SUV features Selec-Trac 4x4 System features a full-time mode that will automatically switch from 2WD to 4WD depending on the terrain. The 2.0-litre diesel engine powering the off-roader produces 268bhp and 400Nm torque and comes mated to an eight-speed automatic gearbox.

### 3.2 Upcoming Off-road SUVs in India 20-21

- **FORCE GURKHA**



**Fig10: New-Gen Force Gurkha**

The new-gen Force Gurkha will be launched in May 2020. This model is one of the best off-roaders currently on sale in India. It comes with all-new exterior design, new and feature-loaded interior along with mechanical upgrades. Based on the new chassis and bodyshell, the 2020 Force Gurkha is now compliant with new crash test and upcoming pedestrian safety norms. The new Force Gurkha is a 3-door off-roader SUV, offering front-facing seats for the second-row occupants and optional side facing seats for the third row. Powering the new Force Gurkha is a 2.6-litre diesel engine, which is capable of producing 90bhp and 280Nm of torque. Power is transmitted to all-4 wheels via a 5-speed manual gearbox. The SUV also gets independent differential locks for front and rear wheels.

- **NEXT-GEN MARUTI GYPSY**



**Fig11: Next-Gen Maruti Gypsy**

Maruti Suzuki had showcased the new-gen Jimny 3-door mini off-roader at the 2020 Auto Expo. The production of the SUV is rumoured to be commenced at Suzuki's Sanand based plant in Gujarat. However, India will get the 5-door long-wheelbase version. It is expected to be launched as the next-gen Maruti Gypsy. To be sold via NEXA premium dealerships, the upcoming model is expected to be priced under Rs 10 lakh. Powering the upcoming Jimny will be a 1.5-litre, 4-cylinder naturally aspirated petrol engine producing 103bhp of power and 138Nm of torque. Transmission choices will include a 5-speed manual and 4-speed torque convertor automatic. It will come with Suzuki's advanced 4X4 – AllGrip system as standard.

- **NEW MAHINDRA THAR**



Fig12: New Mahindra Thar

The next-gen Mahindra Thar is all set to go on sale in India in the next couple of months. The new model is based on the new ZEN3 platform, which also underpins the Scorpio SUV. It will come with significant design changes, new interior and factory-fitted hard-top model. The upcoming Thar will receive an all-new 2.0-litre turbocharged diesel engine, which will also power the next-gen Scorpio and the XUV500. It is rumoured to produce around 140bhp of power and over 300Nm of torque. The off-roader will also receive a new 1.5-litre turbocharged petrol engine producing 163bhp and 280Nm of torque. A six-speed manual gearbox driving the power to all-4 wheels will come as standard.

- **UPCOMING JEEP COMPACT SUV**



Fig13: Jeep Compact SUV

It is no secret Jeep is readying an all-new sub-4 meter SUV to rival the likes of the Ford EcoSport and the Mahindra XUV300. The upcoming model will be based on Fiat Panda's 4×4 platform. It is expected to be the segment-first model to feature the all-wheel-drive system. The new model is likely to be launched in late 2021 or 2022. It is expected to be powered by a de-tuned version of the 1.3-litre turbocharged petrol engine, which will soon power the Jeep Compass.

#### **4. Design and development of Off-Road Vehicle**

- **Constraints**

Raw data related to off-road vehicle safety performance is currently not available. The company will focus on the generation and research on safety raw data in order to create a database for the improved design and evaluation.

Market data on this specific vehicle model is unknown due to its innovative approach. The company will follow up on the main market analysis for the product in order to evaluate the standing feasibility of the project. Customer's feedback will be accounted for in order to adjust the design and production to the most efficient target market

Prior to any design, an intellectual property analysis was completed. The company's design is to be compatible with required specifications, without breaking any copyright or patent regulations. If newly intellectual property is created, then it will be registered appropriately in order to safeguard the company's interest.

Technically, it is recognized that the following constraints are currently found on off-road vehicle designs. The new design and final product will target the following areas for improvement:

- **Design Focus One: Roll Cage Design Requirements**

1. Force Evaluation, the design must withstand minimum impact specifications due to the utilization of this product in rough terrain environments.
2. Ergonomics, previous designs proved ergonomic-challenging. It

is one of the main focuses of this product to be comfortable and safe to the user.

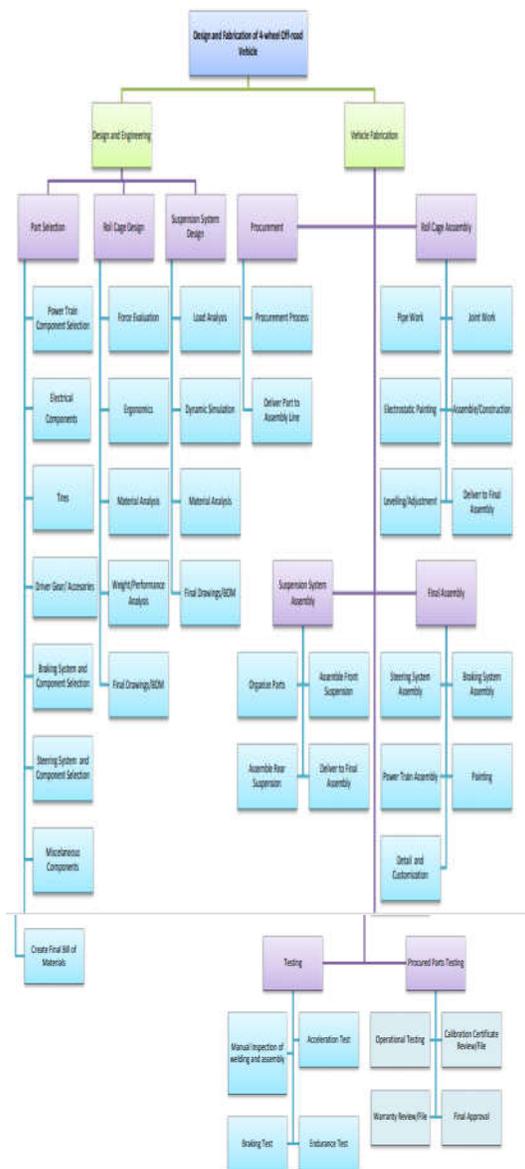
3. Material Analysis, the materials to be utilized for this design must be cost efficient, easy-to-work on, adaptable, easy-to-procure, and performance-achieving.
4. Weight and Performance Analysis, the relationship weight versus performance is important for competition purposes. The vehicle needs to be competitive and attractive to this type of market.

- **Design Focus Two: Suspension System Design Requirements**

1. Load Analysis, will increase the performance of the suspension system, ensuring durability, and safety.
2. Dynamic Simulation, vibration dampening for the users and engine mounts is necessary to ensure safety and performance.
3. Material Analysis, the materials to be utilized for this design must be cost efficient, easy-to-work on, adaptable, easy-to-procure, and performance-achieving.
4. Independent front and rear suspension

5. Front suspension, non-parallel non-equal double wishbone
6. Rear suspension, semi-trailing arms, transmitted to each wheel by external drive shafts. Suspension through coil springs. Each wheel located by a combination of lateral and longitudinal control arms or semi trailing arms to the frame.

Flow chart1: Work Breakdown Structure



- **Steering System and Component Selection (minimum requirements)**

1. Rack and pinion steering, sturdy for the terrain type.
2. The stub axle designed to accommodate the steering arms and the independent suspension arms

- **Power Train Component Selection (minimum requirements)**

1. Engine, 335cc of power, 11HP engine, Piaggio Ape 3 provided by Lombardini.
2. Transmission: 4 forward speeds and 1 reverse,
3. Focus on power to weight ratio of vehicle

- **Tires Selection: Off-road buggy tires, wider set on rear, narrow set on front.**

The manufacturing process will follow industrial engineering best practices in order to maximize throughput, decrease inventories, and decrease operating expenses. A quality program will be implemented by experienced personnel ensuring minimum waste as well as

maximum customer satisfaction. One of the enterprise’s targets is to provide value to the customer while running a feasible and profitable operation

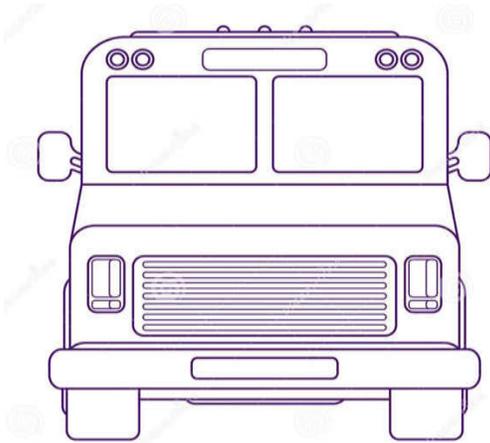


Fig14: Concept diagram of Off-Road Vehicle

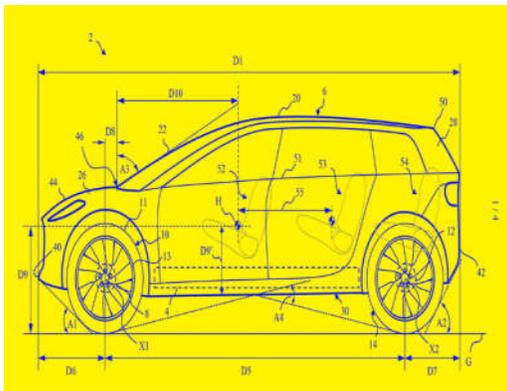


Fig15: highlight different component & dimension of Off-Road Vehicle.



Fig16: Body-on-frame SUVs for 2021 – 2022 Season

If you are a fan of the off-road drive, you will need a strong construction to extend the life of the ride. Most of such SUVs are using a ladder frame, and the body is separated and sits on the chassis. Also called body-on-frame SUVs are bigger than these built on the unibody architecture. But, you will also find large SUVs with different structures.

- **Ruggedness of vehicle**

An ATV is the type of vehicle suitable for traversing rugged, off-road trails. Rugged is defined as durable or sturdy, or a rough terrain or landscape. A big Jeep made for off-roading and going outdoors is an example of a rugged car. A rocky, rough and mountainous landscape is an example of a rugged landscape.

### 5. Off-Road Vehicle Engine

Off-Road Vehicle Engine Market 2020:-  
 Off-Road Vehicle Engine Market also expressly provides data regarding mergers, acquisitions, joint ventures, and every one the opposite vital activities occurred within the market throughout current and past few years. the worldwide Off-Road Vehicle Engine Market report explores manufacturer's competitive situation and provides market share for all major players of this market supported production capability, sales, revenue, geographical presence and different major factors.

- **The engine manufacturing company in India is.**

Ashok Leyland Ltd., Cummins India Ltd., Greaves Cotton Ltd., Kirloskar Oil Engines Ltd., Simpson & Co. Ltd.

Off-road truck vehicles and equipment have diesel engines ranging from 10 to 3,000 Horsepower. On-highway diesel engines (i.e. class 8 long-haul trucks) typically range from 120 to 600 HP.

- **The Off-Road Engine should be capable of performing outcomes such as.**

1. MORE MACHINE CAPABILITY
2. MORE PRODUCTIVITY
3. MORE RELIABILITY
4. MORE UPTIME
5. LESS FUEL USED

6. LESS MAINTENANCE
7. LESS INSTALLATION COST
8. LESS WEIGHT AND SIZE

- **Midrange engine EGR-free design delivers more.**

Simpler, easier installation with greater flexibility for global markets, Higher power density with greater low-end torque for improved productivity and efficiency. Lower total cost of ownership with extended maintenance intervals and improved fuel economy. Cummins 2019/2020 F3.8, B4.5, B.7 and L9 Mid Range engines achieve all this without EGR, Cummins proven Selective Catalytic Reduction (SCR) technology, along with our proprietary Single Module™ after treatment system have enabled tremendous gains in power, performance and productivity for engines ranging from the F3.8 to the L9. Horsepower is increased by up to 10 percent, with peak torque increased by as much as 20 percent.

The Single Module system takes up 50 percent less space than the prior after treatment system, with a 30 percent reduction in weight. SCR, together with advanced combustion technology means fewer regeneration events, saving fuel and extended after treatment service intervals beyond 5000 hours, increasing productivity, Elimination of cooled EGR

allows for a smaller cooling package reducing costs for integration and installation, with reduced heat rejection. This lessens potential maintenance issues. Different types of turbochargers are used depending on the power range and output of individual engines, but all are designed and manufactured by Cummins Turbo Technologies.

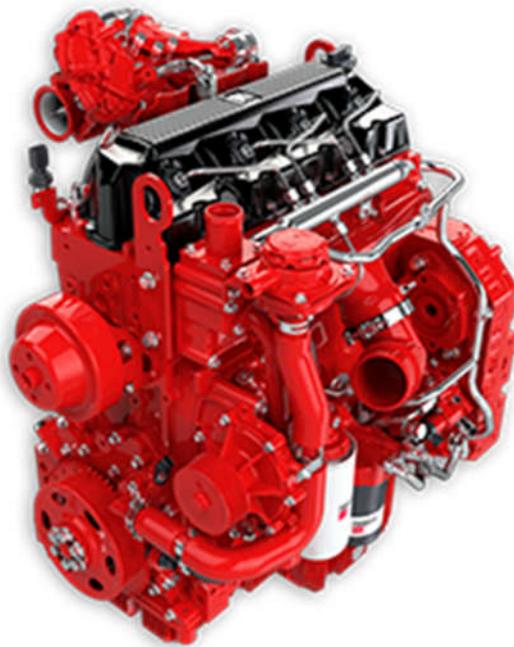


Fig17: 19™, x12™ and x15™ engines for off-highway.

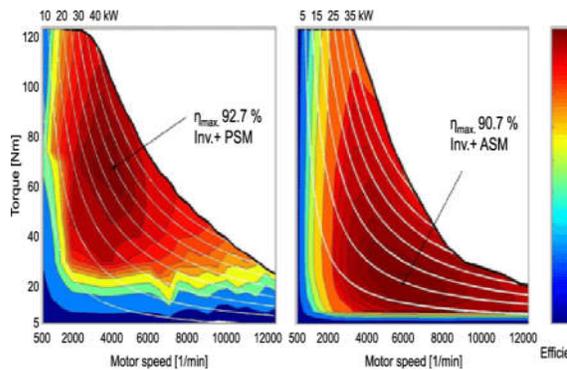


Fig18: Typical efficiency maps of synchronous (PSM) and asynchronous motor (ASM)

- **Proven technology. heavy-duty performance.**

Cummins Heavy Duty X12 and X15 engines are utilized in much larger equipment and experience much greater load factors. We are using proven technology from Tier 4 Final engine models with minor modifications to reach Stage V emission standards. Not only does this make design and integration easier for OEMs, it provides customers with total confidence in a product they know and trust.



Fig19: F3.8™, B4.5™, B6.7™, ENGINES FOR OFF-HIGHWAY.

- **More capable across the globe.**

This is technology that's been proven highly effective and efficient across multiple applications in all types of extreme duty cycles. These engines are capable of operating on high-sulfur fuel, up to 5000 parts per million. No longer is fuel quality a limiting factor for OEMs with a global customer base.

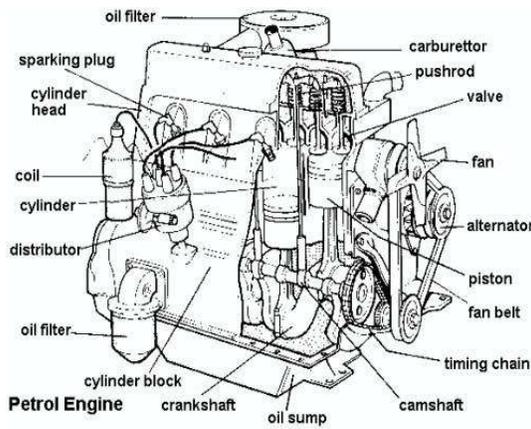


Fig20: Car engine full diagram

- **More advanced options.**

Optional features include Stop/Start technology that adds an additional 5-15 percent greater fuel economy, and Connected Diagnostics™ that allows for analysis and diagnosis by Cummins experts on a real-time basis from remote locations.

- **More support.**

In addition to having remote diagnostic capabilities, Cummins 2019/2020 off-highway engines are supported by Cummins Care, the world's largest and most capable support network with over 7,500 locations worldwide, which has also been upgraded to deliver faster response to customer needs.

- **More to learn.**

This increase in power and performance across the entire power range from 74-675 hp and 600-2500 lb-ft of peak torque could allow you to replace your current engine with one of smaller displacement, without sacrificing anything. Click on the engine link below to learn more about each individual Cummins engine.

- **BSVI SCR Engine Makes You Successful**

The most cost-effective and fuel-efficient technology, Better fuel economy, more profitability, lowest Total Cost of Ownership.

- BS VI SCR electronic engines offer better performance & higher peak torque range as compared to mechanical engines. This results in better fuel efficiency due to

lesser gear shifts, as well as better drivability.

- It offers new advanced electronic features like FE (Fuel Efficiency) switch, LBSC (load-based speed control), VAM (vehicle acceleration management), duty cycle calibration tuning et al which further improves the fuel economy.
- With its customer-first approach, Cummins' BS VI Engines offer features like the Cummins Intebrake a unique compression braking technology that offers better safety to the vehicle and increases service brake life, reducing costs.
- It features advanced filtration technology which helps extend service intervals and addresses inferior fuel quality issues.
- The SCR engine with its advanced fuel systems and improved combustion technology delivers best-in-class fuel economy.
- Combined with Aqueous Urea Solution (AUS), Cummins SCR offers better fluid economy

## 6. Wheel drive for of Off-Road vehicle

Vehicles designed for use both on and off-road may be designed to be switched between two-wheel drive and four-wheel drive so that the vehicle uses fewer driven wheels when driven on the road.

Four-wheel drive, also called 4x4 ("four by four") or 4WD, Refers to a two-axled vehicle drive train capable of providing torque to all of its wheels simultaneously, Most of the Off-Road Vehicle use 4x4 Drive for better grip on the mud road with better performance of vehicle.

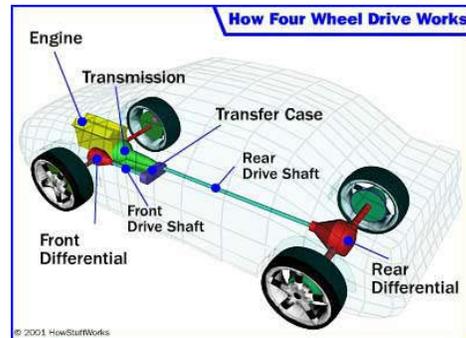


Fig21: four-wheel drive working diagram

6x6's are generally preferred in extremely tough terrains as well as on the basis of the GVW of the vehicle. Military APC's as well as MPV's are generally wanted to have very high requirements of traction as well as protection (armour protection increases weight). Hence, the 6x6 solution works much better

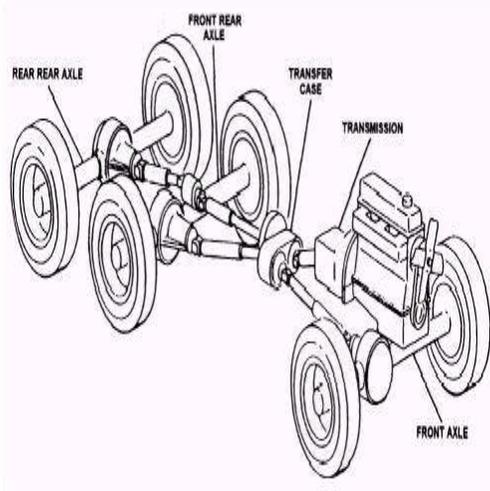


Fig22: 6x6 driving axles



Fig23: Six-Wheel-Drive Mercedes-Benz G63 AMG 6×6

**Off-road vehicle applications**

**Agriculture**

Farms and ranches use diesel to power 66% of all agricultural equipment — almost \$19 billion worth of tractors, combines, irrigation pumps and other farm equipment. Back in 1945, it took 25 million people, 17.5% of the population to farm America’s roughly 300 million acres

of farmland. By 1997, America had fewer than two million farms and less than a million individuals who identified farming as their principal occupation. The average size of a farm had grown from 195 to 487 acres. The number of tractors grew by 3.9 million—an average of about 2 per farm, and 700,000 farms had either three tractors, and another 300,000 farms had four or more tractors. In 1983, the last year for which this data is available, each tractor averaged 66 horsepower. By 1997 a million of the 3.9 million tractors had a power output of more than 100 horsepower.

**Examples of agricultural diesel vehicles & equipment:**

- Tractors: wheel tractor-scrappers, rotary cutters, skid steer loaders, loaders, sprayers, utility tractors, row crop tractors
- Balers: Bale handlers, round/square balers, choppers, mowers, forage harvesters, shredders, windrowers
- Planters & Seeders: air seeder, drills, unit planter
- Other diesel equipment: Hoes, plows, generators, milking machines, grinders, cotton pickers/strippers, combines, irrigation sets/pumps, swather, tillers



Fig24: Application of agriculture

### **Roomy, Expandable Storage**

A compact SUV often offers nearly as much storage as a full-sized SUV -- and far more storage than any car could offer. The Toyota Rav4 is an excellent example of the increased storage space that you can expect when you own a compact SUV. Behind the rear hatch, you'll find 38.4 cubic feet of storage space. For comparison, the Honda Accord sedan tops out at 15.8 cubic feet of trunk space. The CR-V doesn't stop there, though. Lower the back row of seats and you'll increase the total storage space to a whopping 73.4 cubic feet. A compact SUV has the storage space to carry everything you could possibly need for a lengthy adventure.

### **Safer Than Cars**

Cars may be zippy and small compared to compact SUVs. In general, though, they're not as safe. The reason for the relative lack of safety is energy transfer; in a collision

between two vehicles, the heavier vehicle transfers its energy to the lighter vehicle. In fact, if a car and SUV collide, the occupants of the SUV are as much as seven time more likely to escape unharmed.

In terms of safety, a compact SUV actually gives you some of the best features of both cars and SUVs. With a compact SUV, you have a vehicle that's heavier than most cars -- which gives you an inherent safety advantage in a collision. Because a compact SUV has a unibody design, though, you also get crumple zones that can greatly increase your chance of survival in the event of frontal impact. Since many full-sized SUVs use body-on-frame designs, they typically lack crumple zones.

### **Stylish Design**

In the past, car owners loved the versatility of minivans and station wagons. Minivans and wagons weren't terribly large compared to full-sized vans and trucks, and they offered plenty of space for passengers and cargo. A compact SUV offers the same level of versatility in a far more stylish package. Demand for compact SUVs is overwhelming. In 2010, there were 73 different sedans available in the United States compared to 49 compact SUVs. In 2015, there were 66 compact

SUVs on the market and just 48 sedans, if you want to get the car that all of your friends want, you definitely need to consider a compact SUV.

**Some more application of Off-road Vehicle is**

- Mining
- Freight Transport
- Military
- Car-Like Handling
- Better View of the Road
- More Passenger Room

### **Conclusion**

As per my research Off-Road vehicle are more superior than normal car, with better comfort, less vibration and safety features. This vehicle can run easily on mountain area & perform better output as compared to the normal car, This vehicle are mostly preferred for Off-Road driving the people who wanted adventure can go for long drive and enjoy the environment, Off-Road vehicle are most preferred for Off-Road driving also this vehicle are used for commercialized purpose with less investment huge profit is again, Off-road vehicle comes with better output with more facility to the passenger.

Vehicle are mostly referred for Off-Road & Have “N”-Number of applications depending upon the application the customers can selected the vehicle. Off-Road vehicle are used for military operations forces to purpose to perform the Pacific tasks, Off-Road vehicle are used for racing purpose, Off-Road vehicle are design and manufactured with all the global standard, According to me these are the most suitable vehicles for On-Road & Off-Road with better performance.

Vehicle is design & developed with better aesthetic look including lots of feature for better ruggedness and Quality, Vehicle can operated in rough and tough condition & also suitable for any climate and coolest temperature the material which are used can withstand factor of safety and support facture mechanism it can operate under sea also and coldest temperature, The engine generated better output with huge trust and torque the power output in HP is high with less vibration perform, Engine is powerful with BS-6 compliant also give more efficiency and more power output as compared to the normal engines. The vehicle is design in such a minor it can perform all the tasks with enjoyment in ride.

Design is based on environmental view observation concept of what a convertible vehicle is. Not only can you put the top down — or remove it altogether — you can also remove the doors. This kind of versatility is a real advantage, especially when you're out on an off-road

adventure and need to exit or enter the vehicle quickly. It also allows Anderson and Chico area drivers to reduce the vehicle's weight, which improves fuel economy.

I can conclude this vehicle are top most vehicles in India and referred from each and every section also referred for family purpose these vehicle are better vehicles as compared to car also suitable for On-Road & Off-Road, Vehicles can perform all the tasks very fast and easily, The market of Off-Road vehicle is increasing Day-by-Day in coming days lot of peoples are purchasing the market will reach more than 30 % vehicle in India there is demand in market in upcoming days lots of research and development is taking place for Off-Road vehicle, Vehicle comes with affordable price range as compared to car and this vehicle are better as compared to the normal vehicle, Most all the customer are looking for it in India.

### Reference

1. Engine Manufacturer's Association's Supplemental Comments on EPA NPRM for Motor Vehicle and Engine Compliance Program Fees (Docket No. A-2001-09), dated January 14, 2003
2. Willard W. Pullcrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 1997. The temperature in the exhaust system of a typical compression ignition engine will average between 200° and 500°C, whereas the temperature in the exhaust system of a typical spark ignition engine will average 400° to 600° C, and will rise to about 900°C at maximum power. A full list of references can be found at the end of this report.
3. Central Intelligence Agency. (2012). Central Intelligence Agency. Retrieved June 2012, from The World Fact Book: <https://www.cia.gov/library/publications/the-world-factbook/>
4. Chatfield, C. S., & Johnson, T. D. (2000). Microsoft Project 2000 Step by Step. Microsoft Press
5. <https://www.drivespark.com/best-off-road-cars/#jeep-compass>
6. U.S. Department of Agriculture, 1997 Census of Agriculture, "Farm and Ranch Irrigation Survey."
7. 7 "Diesel Technology and the American Economy," Charles River Associates, p. 55 (October 2000).
8. 8 "Diesel Technology and the American Economy," Charles River Associates, p. 27-28 (October 2000).

9. "Off-Road Spotting Basics: "Left. No, no your other left!"". RoverGuide. 2011-12-29. Retrieved 2018-01-19.
10. "The North American Railroad Industry," Association of American Railroads, at <http://www.aar.org/AbouttheIndustry/AboutTheIndustry.asp>.
11. V. Saini and R. Saini, "Driver drowsiness detection system and techniques: a review," *International Journal of Computer Science and Information Technologies*, vol. 5, no. 3, pp. 4245–4249, 2014. View at: Google Scholar
12. G. H. Choi, J. Ko, M. H. You, and Y. S. Kim, "A new mapping method between driver's preference and music genre for automatic music providing system on vehicle," *Journal of Korea Multimedia Society*, vol. 13, no. 10, pp. 1565–1574, 2010 (Korean). View at: Google Scholar