TECHNOLOGIES THAT DRIVE VOLVO's 10X4 DUMP TRUCK

A new dump truck, launched by Volvo Trucks in India, is likely to become a game changer in the Indian mining application business, claims the Swedish truck maker. Built on the proven Volvo FM13 I platform, the Volvo FM 480 10x4 off-highway dump truck has a payload capacity of 43 (US) tonnes. The most unique feature in the truck is a five-axle configuration Volvo has used that promises higher productivity and performance. In this feature, we look at the technologies that drive India's largest truck.

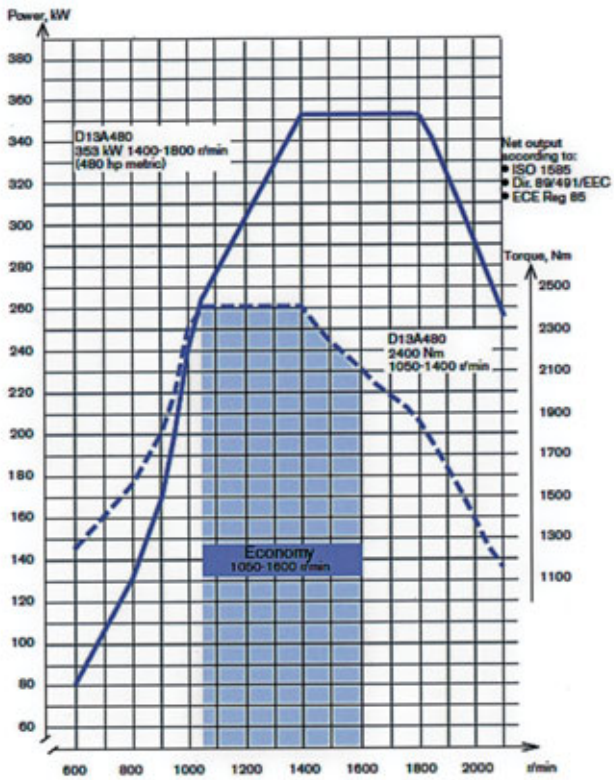
INTRODUCTION

As an industry, mining contributes significantly to India's economy. Its contribution to the country's overall gross domestic product (GDP) varies between 2.2-2.5 %, but its share in the GDP of the total industrial sector is around 10-11 %. Although it is seen as a promising sector for growth, business hasn't been remarkable by any means. In such situations, it is important that the equipments used in mining helps in delivering desired results.

Harping on productivity and efficiency – prerequisites in the mining application business – Volvo Trucks recently launched the FM 480 10x4 dump truck with a payload capacity of 43 (US) tonnes, making it India's first 10x4 off-highway product for mining applications. Philippe Divry, Managing Director, Volvo India Private Limited and a VE Commercial Vehicles Board member said the Volvo FM480 10x4 dump truck looks like a truck, but produces like a machine and could well be the next big game changer in the mining industry.

POWERTRAIN – PERFORMANCE, EFFICIENCY, ETC

Powering the Volvo FM 480 10x4 is a proven engine, the D13A480 – a 12.8 l, in-line, six-cylinder diesel engine that delivers maximum output of 480 hp, and peak toque of 2,400 Nm. Designed specifically



1 Injection architecture of the engine improves fuel efficiency and torque

Rear-located timing mechanism helps lower gas and noise levels

for long-haul and construction duties, the D13A480 features an overhead camshaft, four valves per cylinder and precisely controlled electronic fuel injection.

The unit injectors are vertically positioned and electronically controlled to provide high injection pressures. It also leads to symmetrical distribution of the fuel in the combustion chamber, which along with the inlet manifold are designed to optimise combustion. Better efficiency is also aided by the compression ratio of 18.1:1. This design creates a fuel-efficient engine with high power and high torque within a broad rev range, 1.

A low-emission engine, as regards exhaust gases and noise level, the D13A480 has its timing mechanism located at the rear of the engine. This results in the reduction of number of components, less vibration and permits the fitting of a rear-mounted power take-off. The engine is Euro III approved for exhaust emission regulations.

A complete electronically-controlled system, the Volvo EMS, helps in achieving precise and efficient engine control. The engine control unit is connected to the vehicle electronic system's data links and the information is presented via an easy to read display in the instrument panel.

As an option, the engine also features a system called Closed Crankcase Ventilation that offers fully-sealed crankcase ventilation. A Volvo manual explains that the crankcase gases in the valve cover are returned via a centrifuge-equipped oil separator to the turbocharger. The system separates the oil mist in the centrifuge system, without any need for filter replacements.

The D13A480 engine is mated to the VT 2514B gearbox – a 14-speed range and splitter unit that has a wide range of gear ratios, and close and balanced shift increments. It features steel range housing for heavy duty application, while the clutch casing is made of lightweight aluminium. The use of cable-link gear changing mechanism ensures precise gear slotting.

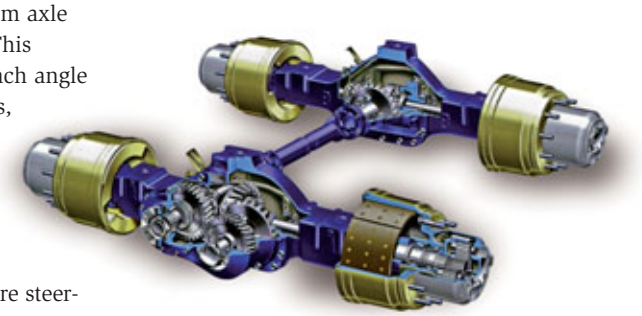
UNIQUE AXLE CONFIGURATION

The Volvo FM 480 is fitted with a unique five-axle configuration that has three steerable front axles and a tandem axle with hub reduction at the rear. This design ensures high front approach angle required for off-road applications, Volvo officials explained during the product introduction.

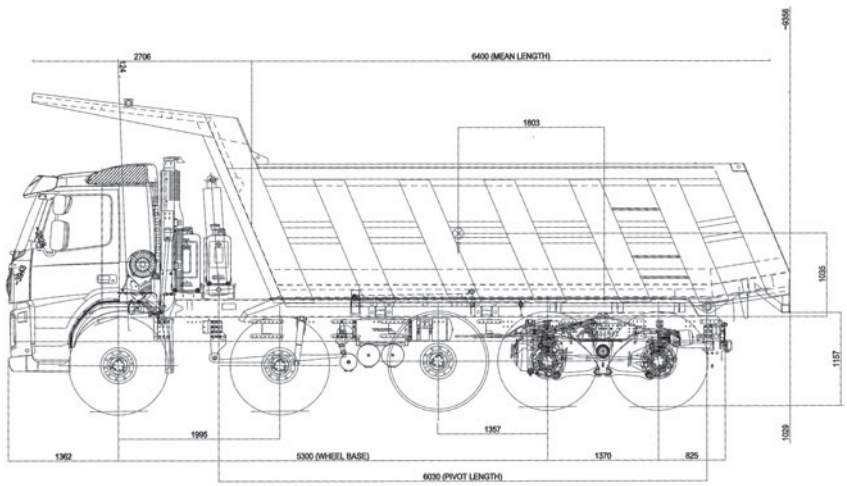
On use are three heavy duty straight I-Beam front axles, with a technical load capacity of nine tonnes each. All the three axles are steerable – while the first two axles are mechanically steerable with hydraulic assistance, the third axle is steered by electronic actuation and hydraulic assistance. This mechanism aids in improving the manoeuvrability and dynamic stability of the vehicle. In addition, these axles are also fitted with maintenance-free unit bearings pre-mounted in hub, leading to faster repairs and less maintenance.

The rear axle duty is done by Volvo's RT3210HV tandem axle with hub reduction, marked for an engine torque of 3,100 Nm. The maximum axle loading is 32 tonnes, while the combination weight is 100 tonnes. It consists of two spiral bevel single gear units, with a distribution gearbox in the forward rear axle. Because of the two-axle drive, the tractive effort can be transferred to the ground without wheel slip, resulting in better grip and very low tyre wear. The axle casing is cast in nodular iron, giving a compact design with high ground clearance.

Most of the torque conversion takes place in the reduction gears in the wheel hubs. The hub reduction gearing consists of a cylindrical planetary gear with straight-cut gears on needle bearings. From the sun wheel, which is mounted on the driveshaft, power is transferred to three planetary gears connected to the wheel hub. When the planetary gears are



Twin-axle drive improves wheel traction



Dimensionally, the 10x4 is India's largest truck

forced to rotate against the ring gear, which is rigidly fixed to the rear axle casing, the rotation speed is geared down.

The RT3210HV is fitted with three differential locks, one for each rear axle and one for the distribution gearbox. The differential lock for the distribution gearbox couples together the drives of the two rear axles, while the one on the rear axles couple the driveshafts to the differential casing. When all three differential locks are engaged, all drive wheels are forced to rotate at the same speed. These locks are controlled by a two-stage switch on the instrument panel.

CHASSIS – WELL DESIGNED FOR HEAVY LOAD

Volvo has used high-strength steel on the FM 480 chassis, with frame section thickness of 8 mm, flange width of 90 mm and height of 300 mm. The front section of the chassis is bent outwards to accommodate the cab and engine, and has uniform material thickness in the web and flanges. A 5 mm thick reinforcement profile is used along the full length of the chassis frame.

The front two axles get three-leaf parabolic spring suspension that feature rubber spacers in the ends and between the spring leaves to ease driving on bumps, and reduce overall vibration. The third axle, interestingly, has electronically programmable air suspension that ensures correct load distribution across the vehicle under the given GVW. There are additional protective covers on air suspension bellows, a helpful feature in mining conditions.

The rear suspension has 11 leaf springs laid out in a bogie design. The leaf springs and axles have rubber springs in between, which contribute to good comfort under all axle loads.

OTHER FEATURES

Some of the other critical characteristics of the FM 480 10x4 include the following:

Cab: The FM L1EH1 cab is crash-tested, and Volvo claims this cab has an injury-preventing design made with energy-absorbing materials. While the sections of the cab are manufactured in galvanised sheet metal, the entire cab has been given an anti-corrosion treatment. The Front Under-run Protection System (FUPS), integrated in the front bumper-carrier, prevents smaller vehicles from being wedged under the front in the event of a collision. A cab tilt angle of 70° helps in convenient service and repairs of components in the engine compartment.

ECUs: To promote active interfacing between the vehicle and driver and to ensure optimum performance of the vehicle, Volvo has offered five ECUs in the FM 480 10x4. The Engine ECU (EECU) monitors the functioning of the engine, while the Light Control Module (LCM) controls and regulates external lighting of the vehicle. There is an Instrument ECU (IECU) that processes input signals from control units and sensors for driver information, and a Suspension ECU (SECU) that monitors the air suspension on the third axle. Functioning of all these ECUs are coordinated by one Vehicle ECU (VECU).

Safety: A key safety feature, apart from the crash-tested cabin and FUPS as mentioned earlier, is the injury preventive interior trim. The instrument cluster and all other interior trims, for instance, are placed at knee height and are made of energy absorbing materials to reduce the risk of personal injury. Even the steering wheel deforms in a predetermined manner.

:: Active Safety measures: The FM 480 features a host of active safety measures, including a battery cut-off switch that decreases the chance of fire because of overcharging. A Fail Safe Braking System is available for brakes to apply when air pressure is low. To ensure proper sitting of the body on the sub-frame, there is a Body Tipping Position Sensor.

:: Passive Safety: Apart from the basic three-point seat belts for the driver and co-driver, the FM 480 offers a propeller shaft guard to prevent the propeller shaft from falling in the rare case of a breakage. Additionally, there is a Tail Gate Protection to reduce penetration of scow end into the cab and retain survival space for the occupants.

Integrated Split Gear: A compact and sturdily supported split gear is fitted on the input shaft in the forward part of the basic unit. This split gear is operated by compressed air, and the split cylinder is integrated into the clutch casing. A button on the gear lever knob helps in preselecting the high and low positions of the split gear. Shifting takes place as soon as the clutch pedal is activated.

In the low split position, a downshift takes place that halves the shifting step between two basic gears. The low split function helps in selecting the correct gear in relation to the engine's economy speed, leading to lower fuel consumption. The high split, together with the sixth gear, provides a direct gear, where the power passes straight through the gearbox with minimum of friction loss.

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