Standard Operating Procedure (SOP)

Mobile Cold Mixer cum Paver

NMHS Project: Application of cold bituminous based eco-friendly road building technology for the special featured Himalayan regions

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In IHR environmentally fragile hilly regions might not be suitable for typical road construction techniques like hot mix asphalt. The narrow and tough site location creates difficulties in the transportation of materials and construction equipment. Also, space is not available for hot mix plants set up in hilly regions. Construction of hilly roads is generally conducted using a manual method, which leads to poor construction quality. To alleviate the issue, a machine **Mobile Cold Mixer cum Paver** is fabricated which can be used for cold mix production and laying. The effectiveness of the machine is evaluated through actual field trial conditions. Results show that the variability of the bituminous mix is reduced by using the mechanized method compared to manual methods. The developed machine was transferred to the industry for large scale production. Also, guidelines for laying of mechanized cold bituminous layer was recommended to NRIDA and BRO.

This technology has been dedicated to the Nation by Sh. Nitin Gadkari, Hon'ble Union Minister for Road Transport & Highways in the presence of Dr.Jitendra Singh, Honourable Minister for Science and Technology and Earth Sciences and General (Dr.) Vijay Kumar Singh, Honourable Minister of State for Road Transport, Highways and Civil Aviation . After a trial section of 1000m at Jhimar, Uttarkhand NHIDCL, BRO and NRIDA. BRO has already implemented the technology at Shillong and recommended for large scale implementation.

Applications

Mobile Cold Mixer cum Paver is mainly used to construct the new roads and to maintain the existing once. It can also be used to correct road damages such as rutting, raveling, descending friction resistance of road surface, cracks and so on also place road construction layers using cold mix technology like Pre-mix Carpet, seal coat and slurry seal to seal the surface, to enhance the skid resistance and other benefits to the road surface. This equipment can be widely used in the construction processes of general cold mix asphalt layers, slurry seal course, modified slurry seal surface sealing etc.

2. Technical Specification of Machine

Mobile Cold Mixer cum Paver (MCMP) provides facility for onsite mixing and laying of cold mix bituminous material on a prepared granular/old surface. It is a single integrated unit which can be mounted on chassis of truck. It is having separate arrangement for storage and proportion ting (by weight) of following materials

- Two grades of aggregates (two separate aggregates bins)
- Mineral Filler material bin
- Bitumen emulsion tank
- Water tank
- Chemical additive tank

- Along with this, the integrated unit has the power supply arrangement and all the accessories required for proportion ting and mixing etc.

The MCMP is having:

- Capability of laying; (a) a thin bituminous surfacing (20-30mm), (b) liquid seal coat and (c) structural cold bituminous layer (minimum 40mm) in mechanized manner.
- Provisions/arrangement to weigh each individual material as per design mix proportions. The tolerance limit of weighing shall not be more than ±2% of each ingredient.
- A capacity to produce a minimum 3 cubic metre of cold mix per a charge/batch
- ➢ The mix is being laid by a hydraulic driven detachable spreader box. The width of spreader box shall vary from 1.75m to 2.25m. It shall have capability to evenly spread the mix to the specified thickness.
- ➢ Maximum height and width of the fabricated unit (over and above the standard chassis) are not to be exceed 2.0 m and 2.5m, respectively.
- ➢ Maximum length of fabricated unit with and without spreader box is not to be exceed exceed 9m and 7.2m, respectively.
- ➢ The hydraulic/pneumatic control /electronic control panel units is having the real time display.

The MCMP is having:

The material of construction and fabrication of facility capacity of each parts are as below:

Aggregate Bin 1: (Minimum 2 Cubic Meters (minimum 3 tonne) capacity)

- Made of Mild Steel (MS) sheet of sufficient thickness to bear the aggregate load without bending/failure

Aggregate Bin 2: Minimum 1 Cubic Meters (minimum 1.5 tonne) capacity

- Made of MS sheet of sufficient thickness to bear the aggregate load without bending/failure

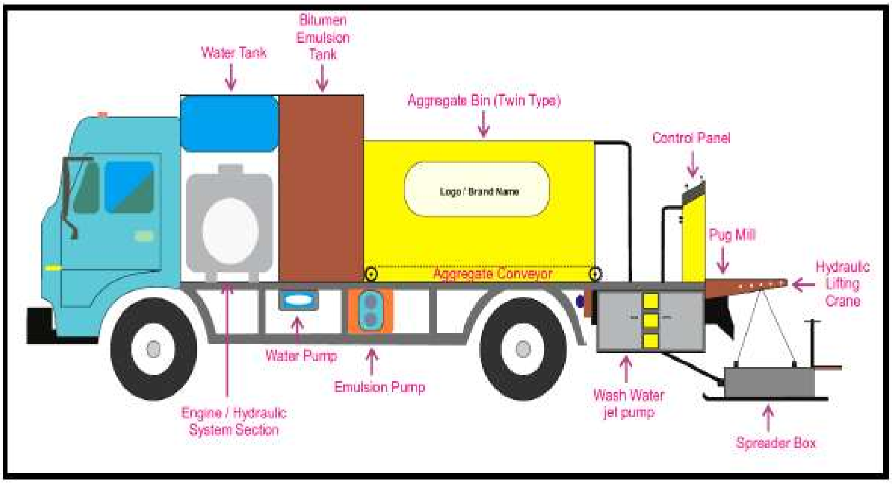
Filler Bin: (Minimum 200kg Capacity)

- Made of MS sheet of sufficient thickness to bear the material load without bending/failure

Bitumen Emulsion Tank:

- Minimum 1000litre Capacity
- Made of corrosion resistant MS sheet of sufficient thickness to bear the material load without bending/failure
- Made of profile and corrosion resistant MS sheet/Plastic of sufficient thickness to bear the material load without bending/failure

Water Tank: (Minimum 1000litre Capacity)



Chemical Additive Tank: (Minimum 100 liter Capacity)

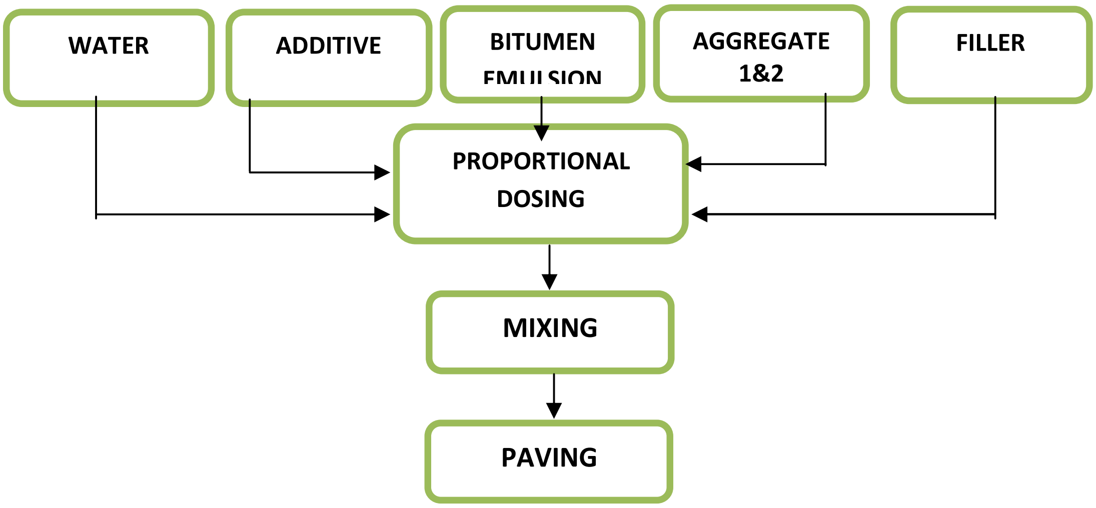
- Made of non reactive to alkaline/acid material and corrosion resistant Stainless-steel sheet of sufficient thickness to bear the material load without bending/failure

Twin shaft pug-mill:

- Minimum output 400kg per minute.
- Made of MS sheet with ceramic coating of sufficient thickness to bear the material load without bending/failure .
- Required hydraulic and pneumatic tubing should be attached for proper working of machine
- Storage bins, storage tanks, pipelines/tubes used in fabrication shall be corrosion resistant.
- ➢ In addition to material storage tank and bins, the machine is having following parts and arrangement:
- Sufficient capacity Diesel/petrol engine for driving hydraulic pumps.
- Sufficient capacity Hydraulic pumps and motors
- Electronic integrated pneumatic system including solenoid control and valves
- PLC (programmable logic controller) based control panel with HMI display.
- Illuminated selector switches-based control panel with emergency stop.
- Hydraulic system driven Conveyor Belts/ Screw conveyors for proportion ting of Aggregates and Filler.
- Hydraulic system driven heat jacketed Lobe/gear Pump for dosage of Bitumen Emulsion.
- Hydraulic system driven (HSD) gear pump made of stainless steel for dosage of chemical additive.
- H SD Centrifugal and Pressure jet pump for dosage of water and cleaning, respectively
- Hydraulic system driven twin shaft pug- mill with strong augurs for mixing components.
- Hydraulic system driven Spreader Box with adjustable opening and fixing of layer thickness.

The cold-mix asphalt technologies environment friendly road construction and maintenance techniques where no heating of bituminous or other components is done during mixing or laying phase of road construction or maintenance.
This technology includes CM-BM (Bituminous Macadam), CM-SDBC (Semi Dense Bituminous Concrete), CM-PMC (Pre-mix Carpet), CM-Seal Coat, Slurry Seal, Micro-surfacing, CM-Pothole Filling, CM-Surface Dressing etc as per IRC SP 100 (Indian Road Congress).
It is the automated process of convey the aggregate, filler (mostly cement), water, bituminous emulsion and a break control additive (any or all of components) in a certain ratio, into the mixer, which quickly mix the components properly in a homogenous, workable mass and discharge it into the paving box (spreader box), which with the movement of carrier truck, pave it evenly on the desired surface.

Mobile cold mixer cum paver is the special machine for producing and laying of various cold-mix asphalt layers, with advantage of automated dosing of components, very short mixing time, quick and homogenous mix mass and spreading in desired thickness. It provides advantages like exceptional quality control, fast construction, low wastage, less cost and low energy consumption etc.



Structural components

- **Chassis-** Special auxiliary chassis fixed below the machine is heavy duty and durable.
- **Feeding System-** This machine has been provisioned to feed any or all of five components as below depending on type of surfacing, mix design and application requirements.
- Aggregate Conveyors
- Bitumen Emulsion Supply
- Water Supply
- Filler Conveyor
- Additive Supply

Aggregate Conveyors

This system provides required quantity of two type of aggregates to the cold-mix asphaltmixtures, and including the following units:

- **<u>Aggregate Bin-1</u>**: Storage volume of aggregate (SVA)is 2 m^3.
- **<u>Aggregate Bin-2</u>**: SVA is 1 m^3. make more room for aggregate bin-1 in case need arises.
- **<u>Independent Aggregate Conveyor-1:</u>** Independent aggregate conveyor for aggregate bin-1 is easy to fix and remove for maintenance.(fully adjustable)
- **<u>Adjustable Feed Gate-1</u>**: A sliding gate type adjustable door on feed mouth of aggregate bin-1 is easy and fast way of controlling the quantity of aggregate discharge from this bin. In synchronization with conveyor belt speed hydraulic control, it gives infinite flexibility in maintaining aggregate gradation requirements of cold mix asphalt mixes.
- **<u>Independent Aggregate Conveyor-2</u>**: Independent aggregate conveyor for smaller aggregate bin-2 is also easy to fix and remove as need arise. (fully adjustable). Both conveyor-1 and 2 have interlocking proportionating through chain linkage.
- **<u>Adjustable Feed Gate-2:</u>** A sliding gate similar to feed gate-1 on feed mouth of aggregate bin-2 is also the easy and fast way of controlling the quantity of aggregate discharge from this bin. In synchronization with conveyor belt speed hydraulic control, it gives infinite flexibility in maintaining aggregate gradation requirements of cold mix asphalt mixes.
- **<u>Strong Power:</u>** Strong hydraulic motor drives both the conveyors at stable speed, which provides accurate and convenient control of aggregate dosing and the system is equipped with highly sensitive and advanced speed sensing device with real time feedback of motor speed.

Bitumen Emulsion Supply System
This system supplies bitumen emulsion to the cold-mix asphalt mixtures. This includes the following units:

Emulsion Tank: 1000 Litres
Emulsion Pump at Stable Flow Rate: State of the art positive displacement pump made of Stainless Steel; corrosion resistant grade specially designed for MCMP. It has high volume efficiency and stable flow rate; It is jacketed pump with warming function from engine radiator water to help pump retain effortless working even in harsh working environments. With strong pumping action, this pump ensures complete drainage of emulsion from the tank and double up as emulsion loading pump by providing sucking action when three-way valve is kept in proper position.
Solenoid Direction Control Valve: Advanced solenoid direction control valve provides the running of emulsion pump in clockwise and counter clockwise direction for dosing or emulsion loading functions as well as flushing of pipelines. In combination with hydraulic flow control valve at operator panel it ensures accurate and convenient dosing of bitumen asphalt into the asphaltic mix. The calibrated flow can be scaled up and down by the operator in case of changing material and weather conditions.
Pneumatic Control Valves: The pneumatic control vales can run on automatic or manual mode by the operator. They control the flow of bitumen emulsion to mixer or re-circulate it to the tank by pneumatic interlocking for better reliability.
Strong Power: Powerful hydraulic motor drives emulsion supply system at stable speed. Efficient speed sensing through special sensors ensures real time reporting of dosing parameters.

Water Supply System
This system supplies water for aggregate moistening, formation of slurry / micro-surfacing mix consistency, high pressure wash flushing and water spraying. This system includes the following units:

Water Tank: 1000 Litres
Stable Water Pump: The high output in-line centrifugal pump provides uniform pressure and quantity of water which can be controlled through pneumatic and check valves available in loop system.
High strength Acrylic Rotameter: This rotameter is used to assess the rate of flow of water and is placed at a convenient spot for easy observation by the machine operator. This instrument is rugged built and better suited for mobile machinery with high levels of vibration. It also ensures 360 - degree observation as the readings are visible from around the rotameter.
Hydraulic Solenoid Valve: As the pump is driven by specialized hydraulic motor, the operation of same is achieved by the electro-hydraulic solenoid valve, which is controlled from the main control
panel. The speed of water output can be regulated through control of hydraulic oil flow by special valves installed in hydraulic system.
Pneumatic Control Valve: The pneumatic control vales can run on automatic or manual mode by the operator. They ensure start / stop of water dosing as well as bypass to the tank for no overload system.
High Pressure Washing / Flushing Device: Equipped with variable jet type adjustment on spray gun, this system provides the convenience of the daily washing, cleaning and maintenance of paving parts and other equipment. This system can also double up to pre-wet the application surface in case of hot weather or the mix requirements.

Filler Supply System
This system supplies the mineral filler (mostly cement or hydrated lime) to the mixer as per requirement of mix design. This is in feed chute style with twin shaft drive for loosening of fine powders and the spiral feeder which ensure stable discharge volume and accurate proportioning. Driven by strong hydraulic motor, this gives trouble free service for years.

Additive Supply System

This system supplies break control additive to certain mixes where controlled breaking of emulsion is important like slurry seal, micro-surfacing etc. Since this system uses chemicals, all its components are made from chemical resistant stainless steel. The flow of additive is controlled by the pneumatic vales which can be run on automatic or manual mode by the operator.

Mixing System

The mixing system is designed to produce homogenous mixes (complete coating with bituminous emulsion) at shortest possible time. It consists of mixer barrel, gear box, mixer shaft, blades and distribution bin. The above-mentioned materials are continuously fed to the mixer to produce accurate mixture as per mix design. This system is made of properly arranged paddle blades fixed on fast rotating double shafts in overlapping circular and angular motion, which ensures complete and quick mixing. The mixer is run by a very strong, high torque hydraulic motor which is controlled by the operator from control panel. The RPM of the mixer can be changed by controlling the flow of hydraulic oil to the motor, if a need for changed mix properties is required. The components of the mixer are made from better abrasion-resistant mild steel for long service life. The mixer is also tilt-able downwards for ease of discharge of some mixes with higher percentage of heavy aggregates and while working on hilly slopes and over bridges. The tilting mechanism is also hydraulically controlled by the operator. The discharge volume (Max. 700 Kgs/min))

Spreader Box / Paving System

The Paving system consists of the specially built spreader box and is independent of materials or mixing part of the main paver. This part is detachable from the main paver by simple removal of few lock-bolts and hydraulic hoses. This system spreads the cold-mix asphalt materials (discharged from the mixer) on the required surface in even layers in required width and thickness. This box is specially built to handle bigger aggregate size and comparatively drier mixes. For more liquid or slurried materials, a strip of rubber is placed on discharge slit of thebox to prevent splaying.

Power System

This system holds strong and enough power for smooth working and control operations. It consists of auxiliary engine and the hydraulic units.

Auxiliary Engine

The auxiliary engine is Kirloskar make water-cooled internal combustion engine with rated power of 70kw / 2000rpm. This engine is equipped with turbocharger for better power, performance, and reliability.

Filler Supply System

This system supplies the mineral filler (mostly cement or hydrated lime) to the mixer as per requirement of mix design. This is in feed chute style with twin shaft drive for loosening of fine powders and the spiral feeder which ensure stable discharge volume and accurate proportioning. Driven by strong hydraulic motor, this gives trouble free service for years.

Control System

This system is Programmable Logic Controller based centralized system which is guided through a touch screen HMI with real time reporting of dosing parameters. In automatic mode, this system ensures sequential control and dosing of all components. The machine operator can view the engine and other physical characteristics at one place through divided panels (for Engine running and paver controls) arranged nearby and can effectively control entire machine through easy electronic interface and physical controllers. All controllers used in this system are built for off-road machinery and ensure accurate control over all parameters. The software- based calibration is one of its class in this segment to help operator assess dosing parameters in a glance over a custom graph available for main 3 components. The system when running in automatic mode, has logics and intelligence for best performance. This system is integrated with pneumatics and hydraulics for seamless performance.

Application Process

Step 1- Cleaning the work-site area

The application surface must be cleared of all contaminants such as dust, dirt, debris, loose aggregates, stagnant water etc. Any deformity on this surface like pot-hole, cracks, rutting etc must be corrected and the surface made level to ensure better mix application. The cleaning can be carried using compressed air through a high-pressure road air- compressor. In case of wet dirt, dust, debris etc sticking to road surface, pressure cleaning with water van be employed to ensure better surface cleaning

Step 2- Marking the area of application

Since the paving is usually done in multiple width to ensure traffic management and to ensure better coverage and less overlapping of joints, the area of application should be clearly marked using any standard method of marking. The driver of the truck carrying the machine must be made aware of the length and width of each application. He should be able to drive the truck in manner of marking and at a certain speed required to ensure fine paving.

Step 3- Paving Process and Requirements

The communication between the machine operator and the truck driver is very important as this will ensure the right movement of the truck at time when the operator is ready with the proper level of mix in the spreader box. Usually there is a sign language between these two persons owing to noise produced by the auxiliary engine and long distance between both of them. Optionally head mounted wireless communication can be utilised.

Ensure the truck is parked on the application area with the spreader box in position of start point. Lower the spreader box to the ground while gentle forward movement of truck to ensure right direction of guide rubbers of the spreader box. Check and adjust the layer thickness by manually checking the skid opening on back of spreader box. For thin surfacing where a finishing rubber is used as secondary strike-off, ensure it is straight and not having any bends on lower surface. Check if the data being shown on HMI is OK.

Speed up the auxiliary engine to paving RPM, turn the maual / auto switch to Auto mode. Start the mixer and the components motor start switches on first line of the control panel. From HMI start dosing of components in automatic mode. Operator will visually check the consistency of the mix being discharged in the spreader box and will make adjustments in water or additive dosing if any required due to changed weather conditions.

When the mix reaches a certain height in spreader box, deemed fit for paving by the operator, the operator would signal the truck driver to start moving the truck on certain speed in the line of marking. The manual water spray system can be utilized in case of surface pre-wetting is required under certain weather conditions. In the mix spreading process, it is important for the operator to be attentive to the mix consistency and the level of the mix in the spreader box for quality and better finish of the application layer.

Step 4- Precautions to be taken:

The dosing of each component and the output discharge volume is dependent on RPM of the auxiliary engine, which will change proportionately with the change in engine speed. However, the ratio of the components can become different as the calibration is done on a fixed speed of engine. So, keeping the engine speed constant is important.

To ensure even spread of the mix on road surface, the speed and direction of the augurs of the spreader box must be watched and adjusted by the operator.

Step 5- Paving Completion Processes

On completion of paving cycle, wash the mixer and the spreader box with pressure water jet, if next paving is required at the same site, disconnect the spreader box hydraulic and mechanical parts from the machine and leave it on site. Turn-off all the functions and stop the auxiliary engine after reducing the RPM and cool down.
If the spreader box is not required or no additional paving is planned for the day, The spreader box can be hung in the back of machine using hydraulic lifts, with hydraulic and mechanical parts attached to paver for transporting back to the camp site.
Complete the balance cleaning operations of the machine at camp site like removal of deposited asphalt material, aggregate, mix lumps etc from the spreader box, mixer and the discharge box of the mixer. Emulsion pump must be washed with some diesel to maintain effortless start for next paving.

Step 6- Transportation

Since the machine is in special shape and with protruding mixer / hydraulic lift / jack in the rear, please pay attention to the followings precautions when transporting the truck before or after use:

- Drive the truck slowly in traveling, especially when turning.
- For long distance travel, pay attention to check the truck for essential spares.
- The spreader box should not be kept hanging on the hydraulic Lift / jack for long transportation. It is strictly prohibited to hang it for more than 15 minutes or travel of max 10 kilometres. If the longer transportation is required, it should be transported with a separate vehicle.
- For long distance shifting, the spreader box should be loaded in a utility truck. Care should be taken to avoid any damage to spreader box as it would give imperfections in next paving or the entire working can get interrupted.

Step 7- Storage

When the machine is expected to keep idle for a long time, it should be thoroughly cleaned and prepared as given below:

- Empty the aggregate bins / Filler bin, drain water, additive and emulsion completely.
- Remove deposits of bitumen from the emulsion tank and clean with any flush oil.
- Check water tank for any rusting and apply automobile grade white primer inside the tank.
- Wash additive tank thoroughly with water and dry.
- Check aggregate bins and filler bin for any rusting or scratches. Clean and apply silicon polish to prevent further rusting.
- Release the pneumatic pressure completely, close all feed valves, shut-off power supply and detach the battery terminals from power supply.
- Clean the control panel, check sealing ring for any damage, lock properly.
- If possible, cover the machine with a terpulin cover and store inside a shed.
- Restart the machine for some time every 15 days to lubricate the parts.

Developed machine construction speed is increased by 10 times and manpower requirement is reduced by 20 times as compared to conventional manual process. For construction of 1 Km. road approximately 200 tCO_2 will be saved using this machine compared to conventional method. The construction of road using this machine results in faster progress, better quality and reduced cost as well as emissions.