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Study of Chip Sealing Over a Gravel Surfaced Road

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***Abstract*: -**

Chip sealing or bituminous surface is a normally used process globally for metalled road a roadway. A chip seal embody of a layer of asphalt binder that is superimposed by a layer of assemblage embedded in the binder. It endows aegis to the current stratum layer from tire disservice and a skid obstruction surface texture for vehicles. Chip sealing is ponder a low cost alternative weigh to variant asphalt surfaces and so far as several transit agencies have narrow budgets, its uses is probable to maximize in the future. The government of Madhya Pradesh manage an identical amount of chip sealed roads in lane kilometres. The concentration of this paper is on observation on chip sealed gravel roads in different regions in the state of Madhya Pradesh and comparing it into the following categories regarding chip seals:

- **Materials; binder and aggregate**
- **Standard circumstance**
- **Construction practices**

Chip seals are used regularly in the maintenance and conservation of convergence. The chip seal is constructed by spraying the asphalt emulsion onto the asphalt roadways, then diffusion chips of clan into the emulsion, embedding the chips with air-driven and rubber tired rollers, and ultimately sweeping to recapture the excess chips. Infrequently, the methods is repeated a double seal, with emulsion sprinkle again and a second layer of chips added. The methods seals fine rift in the fundamental pavement surface, minimizing pavement decay by fend water from intruding into the base and sub grade.

***Keywords*: -** Chip Seal, Binder, Emulsion, Asphalt, Gravel Road and Roller.

Introduction

Chip seals have been used since the year 1920's in the United States when they were used as a stratum for low volume gravel roads. Since then it has been used proudly both as a new paving process and as a precautionary handling treatment for existing pavements. In Iceland, chip sealing was first used in 1978 when a 15 km section was paved in southern Iceland. Chip seals are mostly used on low volume roadways with ADT<5,000 although some nations like South Africa and Australia use it on higher volume roads with ADT up to 50,000. The main factor most agencies have a limit on traffic volume for chip seals is because of traffic control. If speed can be limited for adequate amount of time, there are no limits on traffic volume.

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Prior to there is any opinion of design methodology, it must be unequivocal that the selection of those roads that will advantage from the pavement preservation technique vested with chip sealing is the first and most elemental step in the design method. Chip seals are not meant to develop the structural competence of the pavement section. The formula for chip seal success is articulate framed by the following extract: "summarily stated the accurate accessibility to preventive maintenance is to place the right management or handling on the right roadways at the very right time".There are basically only two types of materials used in chip seals: vadium and aggregate. Aggregate election is a function of geography, where availability and transportation distance virtually explain the aggregate cost function. Aggregate selection is not only a function of seeking optimum gradation; it is also a function of electing the most suitable chip seal for the project. The Long-Term Pavement Program included the Specific Pavement Study 3 (SPS-3), which looked specifically at the timing of pavement maintenance actions. It found that roadways that were in poor prerequisite (i.e., exhibited high levels of distress)when a chip seal was applied had a possibility of fiasco that was two to four times greater than those that were in good condition. It also found that "chip seals seem to outperform the other management in delaying the reappearance of distress".

Various types of asphalt binders be able to use in chip sealing. The binder functions as a film or coating on the present pavement and holds the aggregate that is used on top of it to the roadway. Choice of inappropriate binder for a particular project is based on the type of aggregate used, prerequisite of current pavement and expected weather during and following construction. The two most general binder types used for chip seal operations are cutback asphalt binders and emulsion binders.

Chips after emulsion and before emulsion

- Emulsion Binders
- Cutback Asphalt Cement Binders
- Biodiesel binders

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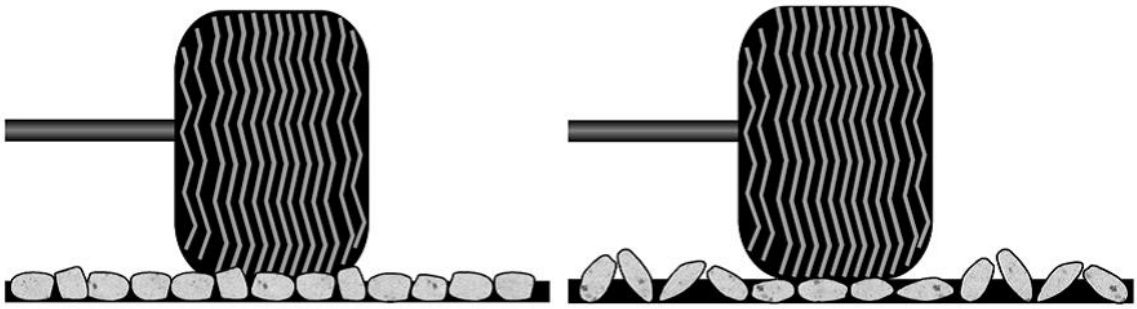
- Aggregate

Process of chip sealing

The chip seal methods start up in the organised stage when the pavement stratum is examined to conclude if a chip seal is a well proper treatment. The stratum critical appreciation is able to consist of estimate the hardness, texture, and other measures of the structural prerequisite of the pavement stratum. If a chip seal is apprize to be proper treatment for the pavement, varied stratum formation methods are then featured on the stratum. Rift mending, selected patching, reselling, levelling, texturizing be able to use to feature the stratum before chip sealing. These treatments should generally perform 6 to 12 months prior to the chip seal to let enough time for treating. The stratum needs to be free of foreign materials before material utility. The application of the chip seal involves indispensable four pieces of equipment: the binder distributor, aggregate spreader, rollers, and brooms.

The binder distributive endow application of the binder to the pavement stratum. A chip spreader quickly applies a uniform, predefined rate of aggregate onto the binder. These two operations are at the heart of construct a stratum that is one stone thick and has sufficient binder to retain the aggregate, but not a surplus amount of binder that causes the stratum to bleed. Depend on the binder, aggregate, and actual type of chip seal being constructed, several rollers will be employed to orient the aggregate to instate proper embedment. Pneumatic rollers are typically found on all chip seal projects. The rollers are ensue by the swab that remove extra aggregate from the finished stratum or surface.



Difference between cubic and flat and elongated aggregates

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Spraying Emulsion

Methodology

Chip seals are constructed by evenly distributing a thin base of hot bitumen or asphalt onto an existing pavement and then embedding finely graded aggregate into it. The aggregate is evenly distributed over the seal spray, and then rolled into a smooth pavement surface. A chip-seal-surfaced pavement can optionally be sealed with a top layer, which is referred to as a fog seal or enrichment.The introduction of polymer-modified bitumen and emulsion binder has increased chisel's ability to prevent crack reflection and improve stone retention by improving the properties of the bitumen binder. Newer techniques use asphalt emulsion (a mixture of liquid asphalt, surfactant, and water) instead of asphalt. This has been shown to help reduce aggregate loss and reduce cost of installation, but can increase stripping. It reduces emissions of volatile organic compounds (VOCs) due to the lower solvent content. New methods also utilize cross linking styrene acrylic polymers which also provide quality water resistance. Chips precoated with about one percent bitumen have been used successfully to minimize aggregate loss and to give the surface a black look.
It can keep good pavement in good condition by sealing out water, but provides no structural strength and will repair only minor cracks. While the small stones used as surface yield a relatively even surface without the edges of patches, it also results in a very rough surface that leads to louder rolling noise from automobile wheels.Road constructed in CMGSY (gravel road) are being taken up for Manual Chip Sealing (Surface Dressing Two Coats) without provision of WBM surfaces.

Before applying bituminous surface treatment, any existing surface gravel with a PI exceeding 10 shall be scarified and removed and the existing surface brought to proper transverse profile. Any irregularities in the longitudinal and transverse direction must be removed. If any granular layer overlay is required, the same should be implemented. Prior to applying the bituminous treatment, the prepared gravel surface must be primed by spraying a Slow Setting Bituminous Emulsion with a kinematic viscosity of 250-500 Centistokes at 600 C at the rate of 12 – 15 kg per 10 sqm area. Surface Dressing is considered a preferred surface treatment for low volume rural roads. The selection of the size of stone chippings should be based on the anticipated traffic and the type of surface to be provided with the bituminous surface treatment. The design of surface dressing may be done in accordance with the design procedure recommended in IRC: 110-2005 Standards specification and Code of Practice for Design and Construction of Surface Dressing.

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Finished Gravel Surface

Pilot project for Demonstration of sealing of Gravel Road and Performance Evaluation continued for a period of two years including rainy season.

All villages having population less than 500 (250 in case of Tribal and IAP districts) are being provided all weather connectivity through construction of Gravel Roads under Chief Minister's Gram Sadak Yojana (CMGSY). It is planned complete this task by the year 2013. Under CMGSY, the gravel roads are being constructed as per provisions of "Manual for design, Construction and Maintenance of gravel roads," IRC: SP-77-2008 and "Ministry of Rural Development, Specification for gravel roads," published by IRC in August 2004.

The surface of road constructed under CMGSY is gravel; therefore, as an inherent limitation, dust nuisance is prominent in these roads. Accordingly, the public acceptability of gravel roads is also relatively low. It has emerged from the literature review that the practice of sealing gravel roads through chip sealing or surface dressing is practice in many countries, however, the use of 20 mm thick pre-mix-carpate is not very common.

As per available information, the sealing of gravel roads has not been taken-up in India on a large scale so far, however, in view of the provisions of Two Coat Surface dressing over Gravel Surface in Gravel Surface in Gravel Road manual IRC SP: 77-2008, it is proposed that the Gravel Roads constructed under CMGSY may be provided with the sealing through Two Coat Surface Dressing.

Since the 'Sealing' of Gravel Roads has not been taken-up in the country on a large scale, it is proposed that the Project may be taken up as an Experimental Pilot project for demonstration purpose.

Technical Report

1. The road was constructed during the year 2010-2011and was completed on March 2012 the details of existing Gravel Pavement with various technical parameters are given below:
   i) Traffic estimated time of construction of Gravel Road 24 CVPD.
   ii) CBR of sub-grade at the time of design of gravel pavement 10
   iii) Composition of the pavement as designed and executed:
      - Sub grade thickness 30 cm
      - Base course thickness 17.5 cm
      - Surface course thickness 5 cm

   iv) Technical parameters of various layers of gravel pavements as executed are:
      - Sub grade – The values of CBR at various RDs is given below:
        RD 0.50 km: CBR 10
        RD 1.00 km: CBR 10
        RD 1.50 km: CBR 10
        RD 2.00 km: CBR 10

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RD 2.50 km: CBR 10
RD 3.00 km: CBR 10
RD 3.50 km: CBR 10

- Base Course- Grading confirms a throughout the length of the road. The values of LL, PI and CBR at various RDs is given below:
- RD 0.50 km: LL 29.2 PI 4.15 CBR 34.14
RD 1.00 km: LL 29.2 PI 4.15 CBR 34.14
RD 1.50 km: LL 29.2 PI 4.15 CBR 34.14
RD 2.00 km: LL 29.2 PI 4.15 CBR 34.14
RD 2.50 km: LL 29.2 PI 4.15 CBR 34.14
RD 3.00 km: LL 29.2 PI 4.15 CBR 34.14
RD 3.50 km: LL 29.2 PI 4.15 CBR 34.14

Surface Course- grading throughout the length of the road. The values of LL, PI and CBR at various RDs are given below:
RD 0.50 km: LL 29.2 PI 4.15 CBR 20.93
RD 1.00 km: LL 29.2 PI 4.15 CBR 20.93
RD 1.50 km: LL 29.2 PI 4.15 CBR 20.93
RD 2.00 km: LL 29.2 PI 4.15 CBR 20.93
RD 2.50 km: LL 29.2 PI 4.15 CBR 20.93
RD 3.00 km: LL 29.2 PI 4.15 CBR 20.93
RD 3.50 km: LL 29.2 PI 4.15 CBR 20.93
The value of AADT with 6% per year growth of traffic works out to be 24.

2) It is proposed that
   a) The casting surface of gravel road should be prepared by making up a regular surface through construction of granular sub base in 5 cm thickness.

   b) Priming by slow setting Bitumen Emulsion grade SSI as per provision of clause 502 of MRD, specification for rural roads, August 2004

   c) Providing two cote surface dressing as per provision of IRC 110-2005

   d) Since the proposed project is a pilot project, performance evaluation of the sealed gravel surface shall be carried out 4 times in a year with respect to following deterioration parameters.
      - Rutting
      - Ravelling
      - Pot-holing
      - Horizontal and vertical cracking
      - Depressions

   e) The work I proposed pilot project would be carried out in presence of a large number of Engineering and Administrative officers and publicity material relating to awareness of villagers above the road would also be prepared.

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f) While sealing the existing the grave road, appropriate traffic diversion would be provided.

Cleaning of Gravel Surface

Earthwork: -

The cost of earthwork generally constitutes 40 to 60% of the total road construction cost. It is, therefore, compulsory that waryopinion is given towards site planning and various operations involved in the execution of the earthwork for economizing the cost of road construction. Since gravel roads are often upgraded later to black-topped flexible pavement standards as the traffic grows, it is both difficult and uneconomical to make up any deficiencies in earthwork at a later stage, pointing to the need for strictly adhering to the specifications laid down in Clause 30 1 ofMORD Specifications. The main activities involved in earthwork operations are:

- Soil survey and laboratory investigations for suitability of material and for determining the CMC andMDD of embankment material compaction.
- The construction of embankment.
- Test pits should be dug in borrow areas from where the embankment materials are to be obtained and representative samples tested for determining their suitability as a fill material as per Specifications. Ordinarily borrow pits along the road should be discouraged. Where permitted by the Engineer, Specifications must be complied with.
- For earthwork filling, in layers, the compacted thickness of the soil layer should not exceed 150 mm when static smooth wheeled rollers of 80 to 100 KN static weight are used. When the earthwork has reached a stage when the usual form of the ultimate shape of the dike has been obtained, the spreading of the earth should be done, in directly reaches, to a crowned magnitude or figure, and to properly super elevated profile if the access is on a curve. The dampness content in the laid soil should be the optimum dampness content subjected to the permitted toleration. Highly expansive soils such as black cotton soil should be convincing at the specified dampness content. The clods could be broken to less than 75 mm size. The equipment for compaction

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should ordinarily be an 80-100 KN tonne smooth-wheeled power roller. For the control of moisture prior to compaction, a truck mounted water tanker should be used, but in the absence of such a water tanker, a tractor-towed water browser could be used.

Important Parameters: -

Gradation of GSB surface course

Is Sieve	Wt. Retained GM	Wt. retained %	Cumulative Retained %	Passing %	Specification passing %
26.5 mm	412 gm	4.12	4.12	95.88%	100%
19 mm	129 gm	1.29	5.41	94.59%	97-100%
4.75	3997 gm	39.97	45.38	54.62%	41-71%
425 Mic.	4299 gm	42.99	88.37	11.63%	12-28%
75 Mic.	906 gm	9.06	97.43	2.57%	9-16%
Pan	257 gm	2.57	100.00	0	

Base Course Gradation

Sieve size mm	Weight Retained (gm)	% of Wt. Retained (gm)	Cumulative % of Wt. Retained (gm)	% of Passing	Allowable limits
53 mm	0	0	0	100	100%
37.5 mm	297	2.97	2.97	97.03	97-100%
19 mm	1072	10.72	13.69	86.31	67-81%
4.75 mm	3386	33.86	47.55	52.45	33-47%
425 Mic	4349	43.49	91.04	8.96	10-19%
75 Mic	790	7.9	98.94	1.06	4-8%
Pan	106	1.06	-	-	-

Conclusion

Maintenance and handling of chip seals play a very vital role in thenation's pavement safeguard program. Here upon, they bear the same scale of technical engineering stiffness that isengaged for the hot-amalgam of asphalt pavements whose designvaliditythe chip seals

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develop. The development further blocked as publicagencies developed a system wherefrom no design is featuredand only empirical rates are used to evolve estimatedamount for unit-price chip seal agreement.

To apply chip seal assurance, investigation is needed to evolve both execution -based circumstance and end product specifications. The quest that most of the non-Government responding department use some form of chip seal assurance makes this type of investigation both timely and important.

All types of chip seal are best applied in the warmest driest weather possible. The temperature of the surface should be a minimum of 21℃ to 54℃ when using emulsion, variable nozzles assent the application of minimise the rate of binder in the wheel paths and combat flooding in the wheel paths, a defect that makes chip seals prone to bleeding. vice versa, the use of pre-spraying texture of a pavement surface before construction of chip seal. The aggregate should be applied as quickly as possible with both emulsified and asphalt cement binders. Waiting for the emulsion to break reduces the effectiveness of the rollers in achieving the desired embedment depth of the aggregate.

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