Full Depth Reclamation

Aditya Mishra, Gorla Harshavardhan Reddy, Shiva Singh

Department of Civil Engineering, IIT Kanpur, INDIA 208016

e-mail: adityam22@iitk.ac.in, harsha22@iitk.ac.in, shivas22@iitk.ac.in

Abstract. To achieve the goal of sustainable development, it is necessary to adopt the method of recycling the resources, reducing the energy consumption and carbon emission along with a low cost and better quality. Full Depth Reclamation is one such method, where we use the materials of existing pavement to rebuild a new road segment. The existing surface course, base course, sub-base, and/or subgrade act as the base of the new pavement and provides a better quality pavement.

Introduction

Full Depth Reclamation is a process of rehabilitation of existing distressed pavement section. In which a full pavement section and a predetermined portion of underlying materials are uniformly pulverized and mixed together to produce a homogeneous stabilized base course. It is basically a cold mix recycling process in which different types of additives such as asphalt emulsions and chemical agents such as cement, fly ash and lime are added to obtain an improved base. The four main steps in this process are pulverization, introduction of additive, compaction, and application of a surface or a wearing course. The treatment of the base layer and recycled asphalt provides a stronger foundation for present and future traffic. This process is effective and economical alternate to produces a solution that maximizes limited budgets.

If the in-situ material is not enough to provide the desired depth of the treated base, new materials may be imported and included in the processing. New aggregates can also be added to the in-situ material to obtain a desired gradation of material.

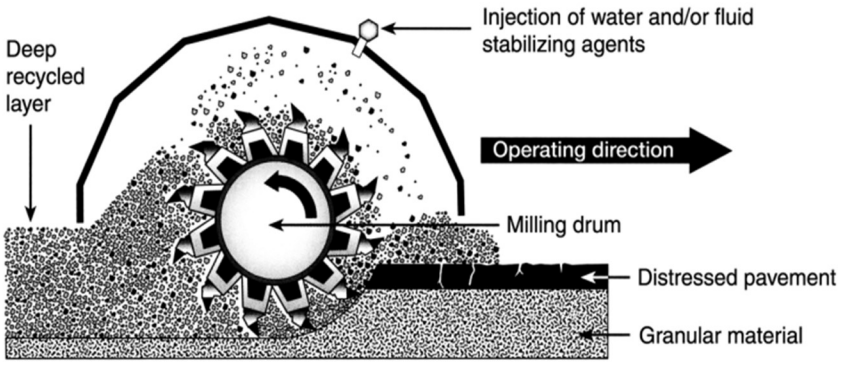

Figure 1: Schematic view of a roadway reclaimer during FDR Process

Procedure

1. **Pulverization.**

   Road reclaimer is used to pulverize an existing asphalt pavement and a portion of the underlying base, sub-base, and/or subgrade as required to meet the requirement of the designed stabilized and homogeneous base thickness depending upon the existing sub grade strength and designed traffic category.

Figure 2: FDR train with water truck and reclaimer

2. **Moisture conditioning.**

   To achieve required density, water is added to the reclaimed asphalt pavement (RAP) by road reclaimer or by using additional trucks.

3. **Breakdown roller.**

   A sheep foot or pneumatic tire roller is typically used to compact the recently pulverized RAP to a consistent density.

4. **Shaping.**

   A grader is typically used to provide proper cross-slopes and grade.

5. **Intermediate roller**.

   A pneumatic tire roller or a steel wheel vibratory roller is used to knead and seat any loose aggregates left from the shaping process.

Figure 3: Final compaction of FDR base with a tamping roller (right) and Smooth Wheel Roller

6. **Finish roller**.

   A 12 to 14-ton static steel wheel roller is used to create a smooth surface.

7. **Sealant.**

   A fog seal is typically applied to protect the finished reclaimed layer. It is used to protect the reclaimed layer so that it can generally withstand traffic loading.

Figure 4: Final product, after the application of sealant

Types of FDR

1. Pulverization.

Among all methods, it is most economical method. In-situ pavement layers and underlying materials upto the pre-determined depth should be pulverized and mixed. No additives should be added except water to get required density. It is used when base, sub-base deficiencies are unknown.

2. Mechanical Stabilization.

It is done by incorporation of imported granular materials such as crushed Virgin aggregate. It improves the gradation of the reclaimed material and increases the structural stability. It is typically used for low to medium traffic volume and when the base is affected by aging.

3. Bituminous Stabilization.

It improves the strength of the reclaimed material while reducing the effects of moisture. It is done by adding additives of emulsified and foamed asphalt. It provides more flexible layer than any other base course. It offers fatigue resistance and resists from cracking. It is best suited for medium to high traffic volume.

4. Chemical Stabilization.

It involves the incorporation of chemical additives like cement, lime, fly ash, kiln dust etc. It can be used for any type of traffic volume showing severe distress caused by heavy wheel loads on base, sub-base not having enough strength.

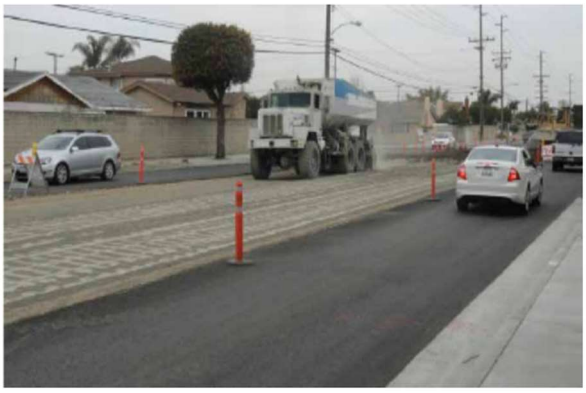

Figure 5: Application of dry cement powder to pulverized mix

Figure 6: Application of cement slurry to pulverized mix

Implementation of FDR in India.

Currently, Indian government is promoting the usage of FDR and some of the projects are:

1. FDR technique is used in Thiruvunanthapuram in upgrading 5 key roads over (Pasuvannara- Aruvikkara- Keezharoor Ring Road, Nedumangad-Aruvikkara Road, Pottenkavu- Nellikkadu- Cheenivila- Thoongampara Road, Amaravila-Koottappo- Sooravakkani Road and Killi-EMS Academy Road). Estimated cost of 65.95cr.
2. FDR was used initially to construct 100km long road stretches in various parts of eastern UP and after that for building another 12,000 km in UP. Examination of the stretches developed through the technology showed negligible wear and tear after six months.
3. The Andhra government approved the proposal of using FDR technology in road construction upto the length of 1000 km in first phase focusing on construction of Vishakhapatnam-Bhogapuram road and Kadapa-Bangalore railway line approach road.

Advantages:

1. It is long term cost effective.
2. Shortened construction schedule due to mechanized construction.
3. Materials and energy are conserved, and air quality problems resulting from dust, fumes and smoke are eliminated.
4. The process is environmentally desirable since disposal problem is avoided.
5. Future maintenance cost are drastically reduced.
6. Frost susceptibility may be improved.
7. Reflective cracks are eliminated.

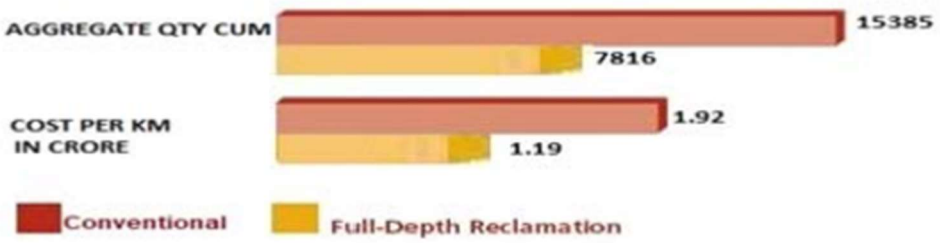

Figure 7: Cost comparison between FDR and conventional method based on data of Unnao bypass road 3.8 KM length and 7.00 M carriageway width.

*Source: Singh et al., *Full depth reclamation (FDR)*, U P Public Works Department, Lucknow.

Limitations:

1. FDR cannot be used for traffic volume greater than 20000 ADT.
2. FDR process should not be opted if the pavement has drainage problems.
3. And also the soil having high plasticity otherwise it may lead to swelling.
4. It involves lot of mechanics- based material testing and performance - based testing procedures.
5. Survey monuments may be destroyed.

Conclusion

FDR reduces the construction cost and time. It is effective in medium traffic . It is the process which provides better strength and long life assurance with limited cost thats why india is primarily focusing on FDR to develop india in a evironment friendly manner.

References

https://www.nijc.org/pdfs/TTAP/BIA/FDR.pdf, last accessed February 26, 2023.

Full depth reclamation for rehabilitation of low volume roads, May 2022, National Rural Infrastructure Development Agency, Ministry of Rural Development, Government of India.

Singh et al., *Full depth reclamation (FDR)*, U P Public Works Department, Lucknow.

https://dpw.lacounty.gov/gmed/lacroads/TreatmentFullDepth.aspx, last accessed February 26, 2023

https://www.fhwa.dot.gov/pavement/recycling/98042/16.cfm, last accessed February 26, 2023.