

## **Study of Different types of Failure & their Remedial Measures in case of Rigid Pavement and A Case Study of NH-160 from Ahmednagar Kinetic Chowk to Vasunde Phata Project**

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**Abstract** - A country's economical growth is depend on the Transportation system available in that country. Transportation system is a backbone of a country's economy. There are many types of transportation like by road, by air, by water, etc. but major mode of transportation in any country is the Road Transportation System. Goods are mostly transferred by road via buses, truck, etc. and one of the cheapest mode of transportation in any country is a Road transport. So, when highways fails in any country it will directly affect the economy of country. This paper investigate the study of different types of failure in Rigid Pavement and what are the remedial measures to repair the failure. Also in this paper we are going to see the case study of NH-160 which is currently present in the state of Maharashtra in India.

**Key Words:** Transportation System, Rigid Pavement, Pavement Failure, Economy.

### **1. INTRODUCTION**

The most important aspect of any developed or developing country is their ability to transfer goods and needs from one place to another with a short period of time. This is possible only when Transportation system of that country should be well developed. This ability of any country make a country Rich by economically, connects nationally and internationally. As we all know that Highways and transportation systems are depend upon each other and linked with the economic development of a country.

The main challenge face by country is to maintain the quality and Standards of Highway. As rigid pavement construction is much more costly than other types of payment, due to that during construction quality and standard of pavement should get maintain by engineer. Due to the compromising in quality of concrete, complete or partial failure of payment will occur and leads to affect the growth of any country or any state.

Failure in rigid payment can be identify by formation of small or large cracks on it, scaling of concrete surface or settlement of PQC slab. There are mainly two major factors affecting the failure of rigid payment.

- Poor quality of concrete
- Inadequate stability of the payment structure.

## 2. OBJECTIVE

- The main objective of the study is to identify the types of failure occur in rigid payment.
- To identify the failure of rigid payment with accurate treatment and with less cost.
- To check the quality of material which are going to use for construction of Rigid Pavement.
- To reduce the maintenance cost of the payment.
- To maintain proper selection of material for different layer as per specification requirement.

## 3. NEED OF STUDY

- Ministry of road transport and Highway constructing the huge number of national highway across the country.
- MORT&H invested lots of amount on Road Infrastructure. As construction of rigid payment is much costly than other types of road, so it is important to maintain the quality of material while constructing the rigid payment.
- To reduce the rate of failure in Rigid Pavement it is important to maintain the quality of Highway.
- As government is utilising huge amount of money on Road Infrastructure it is necessary to build good quality of Highways, so that maintenance cost of highways should be minimize.

## 4. ANALYSIS OF FAILURES IN RIGID PAVEMENT

Types of failure of Rigid Pavement are as follows.

- Scaling of Cement Concrete
- Shrinkage Cracks
- Joint Spalling
- Warping Cracks
- Pumping
- Faulting
- Polished Aggregates
- Punch Out
- Linear Cracking
- Durability Cracking
- Corner Break

1) Scaling of Cement Concrete Road ( Rigid Pavement) -

It is the peeling off or flaking off of the top layer of the concrete surface.

**Reason of Failure-**

- Improper mix design of PQC.
- Excessive vibration during compaction of concrete.
- Performing finishing operation while bleed water is on surface.



**Figure-4.1**

**Remedial Treatment –**

- Full depth slab replacement.
- Scaling surface should Filled with epoxy based grouting material if scaling is moderate.

2) Shrinkage Cracks -

- These are hairline shallow cracks that are less than 2m in length.
- These cracks may form in longitudinal as well as in transverse direction.

**Reason of Failure-**

- Improper setting and curing process of the concrete slab
- higher evaporation of water due to higher temperature.



**Figure-4.2**

**Remedial Treatment –**

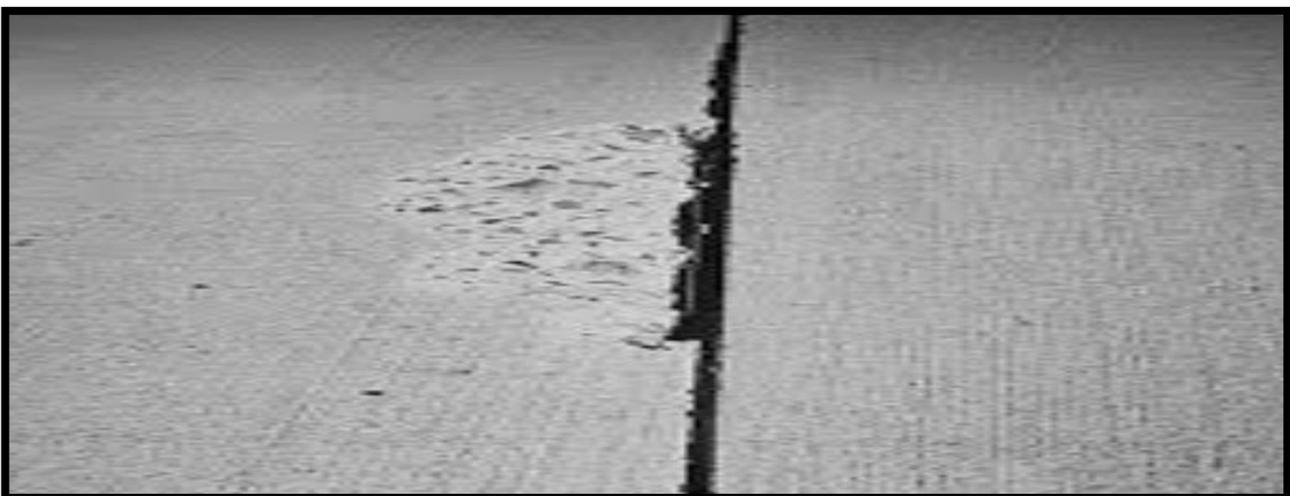
- Shrinkage cracks can be treated by means of crack sealants if they are of moderate size.
- Synthetic resin is generally used as crack sealant.
- Entire slab replacement (full-depth repair) is used if cracks are in extreme situations.

3) **Joint Spalling-**

- It is the breakdown of the slab near edge of the joint due to excess compressive stresses.
- Normally it occurs within 0.5 m of the joints.

**Reason of Failure-**

- Faulty alignment of incompressible material below concrete slab.
- Excessive stress at joint due to wheel load.
- Joint that is accumulated with water that results in rapid freezing and thawing.



**Figure-4.3**

**Remedial Treatment –**

- Partial-depth and full-depth repairs are the remedies for shallow and deep spalling.

4) **Warping Cracks –**

Excessive stress due to expansion of concrete slab results in the formation of warping cracks near the joint edge.

**Reason of Failure-**

- Due to expansion of concrete at joints.



**Figure-4.4**

**Remedial Treatment –**

- proper reinforcement at the longitudinal and transverse joints.

5) **Pumping-**

- When material present below the road slab ejects out through the joints or cracks, it is called pumping.
- When soil slurry comes out it is called mud pumping.

**Reason of Failure-**

- Infiltration of water through the joints, cracks or edge of the pavement forms soil slurry.
- Poor joint sealer allowing infiltration of water.
- Repeated wheel loading causing erosion of underlying material.
- When there is void space between slab and the underlying base of sub-grade layer.



**Figure-4.5**

**Remedial Treatment –**

- Sub grade drainage should be improved.
- Fog seal or slurry seal may be applied to limit water infiltration.

6) **Faulting-**

The difference in elevation between the joints is called as faulting.

**Reason of Failure**

- Settlement of the pavement due to soft foundation
- Erosion of material under the pavement.
- Curling of the slab edges due to temperature and moisture changes.



**Figure-4.6**

**Remedial Treatment –**

- Diamond grinding is used to restore the pavement if faulting reaches 4 mm.
- Dowel bar retrofitting is required if the faulting is between 4 and 12.5 mm

- if the faulting exceeds 12.5 mm complete reconstruction of the slab is necessary.

#### 7) Polished Aggregate

Aggregates which protrude out of cement paste with less angularity and roughness are said to be polished aggregates.

##### **Reason of Failure**

- Repeated traffic applications.
- The age of the pavement will influence polished aggregate.
- It will be quicker if the aggregate is susceptible to abrasion.



**Figure-4.7**

##### **Remedial Treatment –**

- It can be repaired by applying a skid-resistant slurry seal, BST or non-structural overlay.
- Diamond grinding can also be used to treat the problem of polished aggregates in rigid pavements.

#### 8) Punch Out-

- It is the broken pieces of the localized area of concrete slab.
- These are mainly defined by joints and cracks of 1.5m width.

##### **Reason of Failure**

- Heavy repeated loads.
- Inadequacy in slab thickness
- The foundation support loss or the construction deficiency like honeycombing.

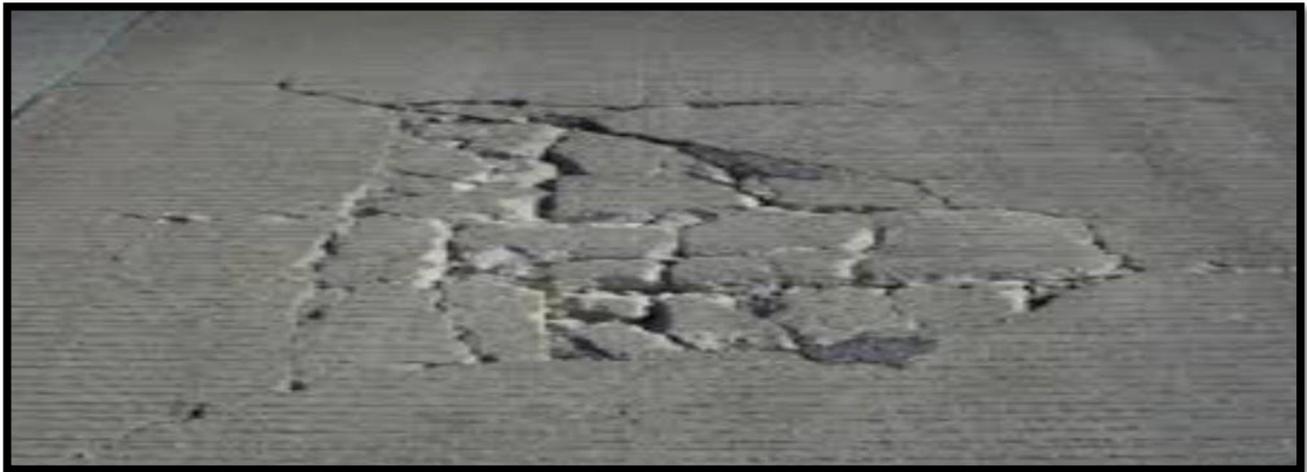


Figure-4.8

**Remedial Treatment –**

- Punch-out problems are addressed by full-depth patch.

9) **Linear Cracking**

- These types of failures in rigid pavements divides the slab into two or three pieces.

**Reason of Failure**

- Failures due to traffic loads at repeated levels.
- Insufficient compaction of base layers.



Figure-4.9

**Remedial Treatment –**

- Crack sealant can be used to seal linear cracking.
- If linear cracking leads to panel cracking, then the pavement is restored by full-depth repair.

10) **Durability Cracking-**

- Durability cracking (D-cracking) is caused by the concrete's inability to withstand environmental factors such as freeze-thaw cycles.
- They are Series of closely spaced, crescent-shaped ,dark colored cracks near a joint, corner.

**Reason of Failure**

- freeze-thaw expansion of aggregate in the DLC slab.
- Some roughness leads to spalling and eventual slab disintegration.



Figure-4.10

**Remedial Treatment –**

- The affected pavement can be refurbished by partial-depth or full depth repair, depending on the severity of the damage.

11) **Corner Breaks**

- These are the failures in rigid pavements that is caused due to pumping in excessive rate.

**Reason of Failure**

- When the pumping remove the underlying support the corner cracks are created.



**Figure-4.11**  
**Remedial Treatment –**

- Full slab replacement or the repair for the full depth must be carried out.

## 5. CASE STUDY

Rigid pavement project NH-160 from Kinetic chowk Ahmednagar to Vasunde Phata NH-160 is recently completed in the state of Maharashtra in India. During case study I have visited this site and observed the types of cracks and settlement formed on NH-160. Also during site visit I have seen that cracked panels are replaced by contractor and some cracks are going to filled with epoxy based grouting materials. During case study I have collected the photographs of cracked and settled PQC panels and all photographs are attached herewith.



**Figure 5.1** Scaling of rigid pavement



**Figure 5.2** Shrinkage cracks



**Figure 5.3** Linear cracks



**Figure 5.4** Corner break



**Figure 5.5** Faulting



**Figure 5.6** Pumping

There are two treatments to repair cracked PQC panels. First is to replace the full PQC panel and second is to fill the cracks with epoxy based grouting materials. Figures 5.7, 5.8 and 5.9 are showing the breaking of PQC panels for full depth slab replacement. Figures 5.10 and 5.11 are showing the reconstruction of PQC panels. Similarly figures 5.12 and 5.13 are showing the cracked panels are filled epoxy based grouting material.

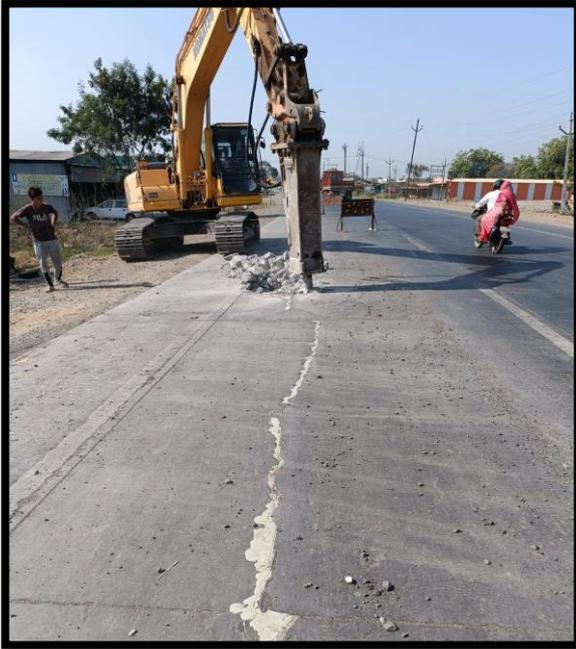


Figure 5.7



Figure 5.8



Figure 5.9



Figure 5.10



Figure 5.11



Figure 5.12



Figure 5.13

## 6. CONCLUSIONS

- Identify the types of pavement failure and then rectify the defects with appropriate treatment.
- During the construction of rigid pavement skilled workmanship should be there.
- During construction of rigid pavement compaction of sub base layers should be done with proper rolling and watering to avoid pavement failure.
- During construction of rigid pavement use good quality of material so that failure of pavement should be minimize.
- To minimize the maintenance cost of pavement, construction should be done with appropriate design and standard specifications.

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