

**FAILURE ANALYSES FOR  
PAVING BLOCK PAVEMENTS: A CASE  
STUDY ON  
SAIT COLLEGE CAMPUS AREA WHERE  
EARLY FAILURES  
WERE EXPERIENCED**

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## **ABSTRACT**

*The aim of this paper is to report on the findings of the subsequent engineering failure study as well as the engineering remedies, and aims to provide industry feedback to prevent similar future failures.*

*The main contributing factors to the rapid failures were identified to be a combination of incorrect and out of specification sand bedding thickness, incorrect sand bedding material, incorrect filler sand and deficient compaction of the paving block layer. These construction defects ultimately caused shear and differential settlements in the sand bedding layer and subsequent water infiltration into and overstressing of the cement stabilized sub base layers.*

*The rehabilitation actions were designed to ensure continual operational usage of the site and maximum utilization of the original pavement structure.*

## **1. INTRODUCTION AND BACKGROUND**

The SAIT campus was constructed during the year 2008-09 and the paver block pavement constructed later. The pavement structure was a concrete block paving structure designed to accommodate 10 to 15 ton wheel loads. The site is mostly used for pedestals. Soon after completion some areas of the pavement started to show localized deformation and paving block movement. During the year of 2011 further deformation and localized failures followed and within a year frequent repairs of failure areas were required to keep the area operational.

Extensive investigations followed to identify the causes of this rapid pavement failure and to find appropriate rehabilitation measures.

## **2. CONSTRUCTION PROCESS**

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In the construction process the control of the final sand bedding and paving block layer finishing off was entrusted mostly to the paving contractor, a lack of both process and quality control on this layer was identified afterwards.

It was concluded from the investigation that proper process control and material approval design procedures was not followed during the construction of

both the stabilized sub base layer and the sand bedding/paving block layer.

### **3. FAILURE INVESTIGATION**

The initial failure investigation consisted of the analysis of all quality control and site records of the construction process. Some causes of failure are as follows-

- Compaction of the base course thoroughly using a vibrating plate compactor was not applied. It is essential that the sub-base is 'compacted to refusal'; that is, compacted to the point where it cannot be compacted any further.
- Adequate longitudinal falls for drainage of water has not given, resulting in the ingress of water through the disturbed and unsealed joints into the lower layer works causes failure.
- Compaction of the paved surface using the vibrating compactor, necessary for pre-stressing (or interlocking) of heavy duty paving block structures was also not applied.

### **4. IDENTIFIED CAUSES OF FAILURE**

Various block paving literature (Knapton and Cook, 2000, Knapton, 1992) best practise manuals (CMA, 1994)

specifications (SABS, 1984 and 1985) and discussions on failure analysis were consulted or employed to pinpoint the causes and subsequent mechanism of pavement failure. The specialist's opinions and literature analyses highlighted the concerns and/ or potential contributory causes summarized below.

- The fine grading and variable layer thickness of the bedding sand was likely to cause differential settlement and shear deformation of the block/sand layer due to the low shear strength of such sands and sensitivity to moisture,
- The relative coarse filler sand will mitigate against effective sand penetration into the block joints and effective sealing of the joints. This increased permeability of the joints, will result in extensive water penetration into the bedding layer,
- The lack of lock-up pneumatic compaction will exacerbate shear deformation of the bedding layer and moisture ingress through the block joints,
- Aeolian sand with rounded grains and too fine a grading will hamper effective load transfer from the block layer to the sub base layer and may cause .quick sand. type failures especially under wet to saturated conditions,
- The poor draining characteristics of the bedding sand, as used, will trap water that permeates into the bedding layer and thereby exacerbates the risk of shear failure risk,

- The insufficient stabilized layer thickness and selected layer material quality, as identified in localized areas, will also decrease pavement life and stability, especially where thick bedding layer areas triggered pavement instability.

**“The primary cause of the rapid failures is therefore believed absence of the compaction of the base course and the paved surface which results overstressing of the layer works and formation of ponds in areas where secondary failures (after ingress of water) resulted”.**

**Fig.1      Overstressing      caused  
failure**

**Fig.2 Pond formation**

## **5. CONCLUSIONS AND VALUABLE LESSONS LEARNED**

The overall conclusion of this engineering failure analysis study was that heavily loaded paving block pavements are, by nature, very sensitive structures and if one or more of the essential structural components is absent, or

become unstable, then rapid pavement deterioration failure will follow much faster than in equivalent concrete or asphalt surfaced pavement structures. Lessons learned from this study, which can be valuable to the paving block industry, include the following critical aspects:

- a. Specifications (like the SABS specs applicable in this case) which represent long-term developed best practice should be strictly adhered to and not passed-off as not possible or as broad guidelines;
- b. Superior process and quality control and technical supervision are required throughout the construction of these heavy duty pavement structures. Combined project manager/contractor roles are not feasible and too risky on these high quality projects - independent and extensive quality control is essential;
- c. The functional nature of the sand bedding layer in the paving block pavement is to dissipate pore pressures and efficiently drain seepage from the surface layer - it should never be underestimated, especially if the pavement will be exposed to aggressive industrial and/ or heavy off-road vehicles;
- d. The structural integrity of the upper base combination layer, consisting of paving block and sand bedding, is crucial in the mechanistic functioning of the heavy duty paving block pavements. A lack of interlocking in the

paving block layer or in stability in the sand bedding layer will quickly lead to surfacing deformation, a drastic reduction in the load distribution efficiency of the block layer and resultant overstressing and further moisture related failures of the upper pavement structure.

## **6. REFERENCES**

CMA (Concrete Masonry Association), 2000, Lock Pave: Concrete Block Paving design programme, RSA.

# **FAILURE ANALYSES FOR PAVING BLOCK PAVEMENTS: A CASE STUDY ON SAIT COLLAGE CAMPUS AREA WHERE EARLY FAILURES WERE EXPERIENCED**

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**Background**

Rohit is a civil engineering student at Sri Auribindo Institute of Technology, Indore. He will complete his Bachelor degree in Civil Engineering in 2013 under the mentorship of Prof. S C Jain.