



## CEMENT CONCRETE PAVER BLOCKS FOR RURAL ROADS

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### Abstract

Solid unreinforced pre-cast cement blocks concrete paver is a versatile, aesthetically attractive, functional, cost effective and requires little or no maintenance if correctly manufactured and placed. Paver blocks can be used for different traffic categories i.e. Non-traffic, Light-traffic, Medium-traffic, Heavy-traffic and Very heavy traffic. Most concrete block paving constructed in South Africa has performed satisfactorily but there are two main areas of concern: occasional failure due to excessive surface wear, and variability in the strength of blocks. Paving block is a very common and popular method of hard landscaping that is suitable for various applications including: driveways, paths, public utility areas, garage, forecourts and roads etc. After the useful life of paver blocks, demolished ones can be used as recycle aggregate conveniently.

This project strictly follows IS 15658:2006 for Paver Blocks. Aggregate which passes from 20 mm sieve and retain on 4.75 mm sieve is going to be used. The removal of contaminants such as reinforcement, paper, wood, plastics and gypsum should be done. Concrete produced with such recycled concrete aggregate is called recycled aggregate concrete (RAC)

In rural area the road construction is under progress, flexible & rigid roads are constructed in combination according to need. Generally flexible payments are constructed outside the village boundary. However the rigid payments are laid inside the village portion. It is seen that the cost of rigid payment is quite high as compare to flexible payment. In this study the work is

carried out to replace the rigid payments by concrete block pavers.

**Key words: Cement Concrete Paver Block**

### Literature Review on Paver Blocks

Segmented concrete paving is a system of individual shaped blocks arranged to form a continuous hardwearing surface overlay. Over the past two decades, paving composed of segmental blocks has become a feature of our towns and cities. It is to be found in commercial industrial and residential areas, in the paving malls, plazas, parking areas and bus stops. It has been successfully used for embankment walls, slope protection and erosion control. During this period, extensive research has been carried out on the engineering characteristics and structural performance of segmental block paving. Existing pavements subjected to heavy bus traffic and industrial loads have been monitored and their service life shown to be satisfactory. The South African Bureau of Standards has published specifications relating to the quality of concrete paving blocks and required standards of construction. The Committee of Urban Transport Authorities has published a catalogue of designs for segmental block pavements. The engineering and specification aspects have been satisfactorily solved, and this type of paving has a proven performance and service record. But the aesthetic use of segmented paving and the contribution it can make to improve our urban landscape is only now being appreciated. History Paver Blocks

Although pavers made out of concrete may be a new product, the use of paving blocks as a surfacing material is anything but new. Flagstones were being used to pave village

streets. Cobblestones were the traditional method of stone paving, being uncut and often water-worn stones or large pebbles about 150mm in size. Later hand-cut stone blocks were introduced. Road-making using brick were also common depended on the availability of clay bricks in India. Concrete paving blocks were first manufactured in the Netherlands in 1924. It was probably World War II that led to the growth of concrete blocks as a paving material. Large areas of the Netherlands were destroyed during the War and, because clay bricks were in short supply, concrete blocks were introduced as an alternative. Subsequently, concrete block paving (cbp) became recognized as a paving material in its own right. The research carried out by Shackel in the late '70s and early '80s remains the most comprehensive yet conducted into the performance of concrete block paving. A hierarchy of block shapes was developed, the existing design curves were examined, the role of the bedding and jointing sands was investigated in earnest, and various base and sub-base materials were tested. Most of the research by Shackel was carried out in South Africa. This has resulted in South Africa being recognized as a world leader in concrete block paving.

Concrete pavers are a versatile paving material, which due to the availability of many shapes, sizes and colors, has endless streetscape design possibilities. The use of concrete block paving can be divided into sub heads like Roads, Commercial Projects, Industrial Areas, Domestic paving and Specialized Applications as Cladding vertical surfaces, Storm water channels, Embankment protection under freeways and Roof decks

Concrete block paving is not limited to flat, level surfaces, but can be laid on near-vertical surfaces to create interesting architectural features. The crocodile farm near Brits used concrete block paving extensively to pave the entire area. Concrete block paving was chosen

because it provided a non-destructible, non-slip surface. Embankment protection alongside freeways. The use of concrete block paving is a very effective and quick method of slope protection. Concrete block paving using specially developed blocks has been used successfully in lining storm water channels. Century City roof deck with a good detail across the expansion joint.

Physical requirement for un-reinforced precast cement concrete paver blocks are categorized under three categories according to IS 15658: 2006 and they are given below:

#### **General Requirements**

1. All paver blocks shall be sound and free from cracks or other visual defects which will interfere with the proper paving of the unit or impair the strength or the performance of the pavement constructed with the paver blocks.

2. When two layer paver blocks are manufactured there shall be proper bonding between the layers. Delaminating between the layers shall not be permitted. The compressive strength of the two layer blocks shall meet specified requirements.

3. When paver blocks with false joints, surface reliefs or projections are supplied, the same shall be specified. Also, the surface features shall be well formed and be devoid of any defects.

#### **Obligatory Requirements**

##### **1. Visual requirements**

Visual inspection of quality of paver blocks shall be carried out in natural daylight, prior to the test for other properties. The inspection shall be conducted by the purchaser and the manufacturer jointly at a location, agreed to between them, normally at the site or factory.

##### **2. Dimensions and Tolerances**

The recommended dimensions and tolerances for paver blocks are measured by steel calipers and steel ruler. Specified tolerance as IS 15658: 2006 is given below in table.

S.No.	Dimensions	Recommended values	Tolerance limit	
			Thickness <100mm	Thickness >100mm
1.	Width, W	To be specified by manufacturer	± 2mm	± 3mm
2.	Length, L	To be specified by manufacturer	± 2mm	± 3mm
3.	Thickness, T	50 to 120 mm	± 3mm	± 4mm
4.	Aspect ratio (L/T)	Maximum 4.0	+ 0.2	+ 0.2
5.	Arris/Chamfer	Minimum: 5mm Maximum: 7mm	± 1mm	± 1mm
6.	Thickness of wearing layer	Minimum: 6mm	+2mm	+ 2mm
7.	Plan area, Ast	Maximum: 0.03m <sup>2</sup>	+ 0.001m <sup>2</sup>	+ 0.001m <sup>2</sup>
8.	Wearing face area,	Minimum 75% of plan area	- 1%	- 1%
9.	Squareness	Nil	± 2mm	± 3mm

Table 1: Recommended Dimension and tolerance for paver blocks

### 3. Water Absorption

The water absorption, being the average of the three units, and water absorption of paver block shall not be more than 6% by mass and in individual samples, the water absorption should be restricted to 7 percent.

### 4. Compressive Strength

Compressive strength of paver blocks shall be specified in terms of 28 days compressive strength. The average 28 days compressive strength of paver blocks shall meet the specific requirement. Individual paver block strength shall not be less than 85% of the specified strength.

### 5. Abrasion Resistance

Abrasion resistance is a property which allows a material to resist wear. Materials which are abrasion resistant are useful for situations in which mechanical wearing and damage can occur, including delicate applications such as the construction of space shuttle components. Numerous companies manufacture abrasion resistant products for a variety of applications, including products which can be custom fabricated to meet the needs of specific users. The Abrasion resistance of paver blocks may be specified in the test results, which should be complied with by the manufacturer.

## 6. Optional Requirements

### A. Tensile Splitting Strength

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure. Apart from the flexure test the other methods to determine the tensile strength of concrete can be broadly classified as (a) direct methods, and (b) indirect methods. The direct method suffers from a number of difficulties related to holding the specimen properly in the testing machine without introducing stress concentration, and to the application of uniaxial tensile load. Which is free from eccentricity to the specimen? As the concrete is weak in tension even a small eccentricity of load will induce combined bending and axial force condition and the concrete fails at the apparent tensile stress other than the tensile strength. As there are many difficulties associated with the direct tension test, a number of indirect methods have been developed to determine the tensile strength. In these tests in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses developed in the specimen. The tensile stress at which the failure occurs is termed the tensile strength of concrete.

The splitting tests are well known indirect tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. Due to the compression loading a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter as obtained from an elastic analysis. The magnitude of this tensile stress  $f$  (acting in a direction perpendicular to the line of action of applied loading) is given by the formula (IS: 5816-1999):

$$f = \frac{2P}{\pi ld}$$

Where P= Maximum load applied in Newton,

l=length of specimen in mm,

d=Cross sectional dimension of specimen in mm

### B. Flexural Strength/Breaking Load

Maximum fiber stress developed in a specimen just before it cracks or breaks in a flexure test. Flexural yield strength is reported instead of flexural strength for materials that do not crack in the flexure test. An alternate term is modulus of rupture. The Flexural strength/ Breaking Load of paver blocks are done when it is required by purchaser and its test value should be specified by the purchaser.

### C. Freeze-Thaw Durability

When water freezes, it expands about 9 percent. As the water in moist concrete freezes it produces pressure in the pores of the concrete. If the pressure developed exceeds the tensile strength of the concrete, the cavity will dilate and rupture. The accumulative effect of successive freeze-thaw cycles and disruption of paste and aggregate can eventually cause expansion and cracking, scaling, and crumbling of the concrete. When required for application in freeze and thaw environment, the purchaser may specify limits to the test results, which should be completed with by the manufacturer.

### D. Color and Texture

Color and texture is given to paver block to make it visible and also for skid resistance or to provide friction. When required, the color and texture of paver blocks should be manually agreed to between the purchaser and the manufacturer.

### E. Grade Destination of Paver and Design of Concrete Block Pavement

Recommended grades of paver blocks to be used for construction of pavements having different traffic categories are given in table below. Since minimum value slump concrete is used in production of paver blocks, the quality of blocks produced will depend upon various parameters like the capacity of compaction and vibration of machine, grade of cement used, water content, quality of aggregate used, their gradation and mix design adopted, additives used, handling equipment employed, curing methods adopted, level of supervision, workmanship and quality control achieved etc

S. No.	Grade Designation of Paver Blocks	Specified Compressive Strength of Paver Blocks at 28 Days N/mm <sup>2</sup>	Traffic Category	Recommended Minimum Paver Block Thickness in mm	Traffic Examples of Application
1.	M-30	30	Non-Traffic	50	Building premises, monuments premises, landscapes, public garden/parks, domestic drivers, paths and patios, embankment slopes, sand stabilization area etc
2.	M-35	35	Light-Traffic	60	Pedestrian plazas, shopping complex ramps, car parks, office driveways, housing colonies, office complexes, rural roads with low volume traffic, farm houses, beach sites, tourist resorts local authority footways, residential roads etc.
3.	M-40	40	Medium-Traffic	80	City Streets, small and medium market roads, low volume roads, utility cuts on arterial roads etc
4.	M-50	50	Heavy-Traffic	100	Bus terminal, industrial complexes, mandi houses, roads on expansive solis, factory

					floor, service stations, industrial pavements etc
5.	M-55	55	Very Heavy-Traffic	120	Container terminal, ports, docks yards, mine access roads, bulk cargo handling areas, airport pavement etc.

## NOTE

1. Non-traffic areas are defined as areas where no vehicular traffic occurs.
2. Light-Traffic is defined as a daily traffic up to 150 commercial vehicles exceeding 30 KN laden weight, or an equivalent up to 0.5 million standard axels (MSA) for a design life of 20 years (A standard axel is defined as a single axle load of 81.6 KN)
3. Medium traffic is defined as a daily traffic of 150 – 450 commercial vehicles exceeding 30 KN laden weight, or an equivalent up to 0.5 – 2.0 MSA for a design life of 20 years.
4. Heavy traffic is defined as a daily traffic of 450 – 1500 commercial vehicles exceeding 30 KN laden weights, or an equivalent of 2.0 to 5.0 MSA for design life of 20 years.
5. Very heavy traffic is defined as a daily traffic of more than 1500 commercial vehicles exceeding 30 KN laden weight, or an equivalent of more than 5.0 MSA for design life of 20 years.

*Table 2: Grades of paver blocks for traffic categories.*

### Outcome of Review

It is observed from the review that paver blocks can be used for different categories of traffic such as Non-Traffic, Light-Traffic, Medium-Traffic, Heavy-Traffic & Very Heavy-Traffic with the confirmation of specifications of Table 2 as shown. In nearby areas of Gwalior the Concrete paver blocks are used in non-traffic area but not in traffic roads. These can be used on roads for different types of traffic roads.

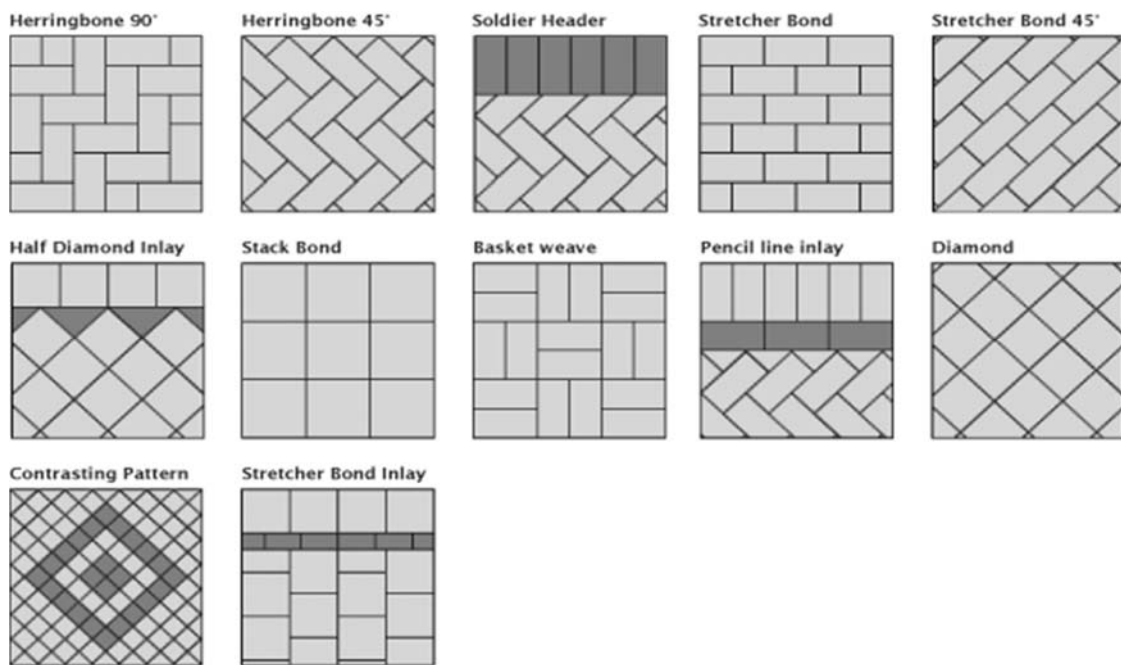
The object of this paper is to draw attention of Road Developing Authorities to use these blocks in habitation area where the speed of vehicles is restricted. These blocks are precast blocks so their quality can be monitored at construction shed & not at road site. At road site the well compacted base will be essential to lie. The well compacted base is also essential in case of concrete roads. The different types & shades of concrete paver blocks, their patterns & jointing arrangement are shown below



Different types & shades of concrete paver blocks



Concrete Paver Blocks Laying patterns



Different Jointing Arrangements





Typical Arrangement used for Drive Way

### Conclusion

As per above review, these concrete paver blocks can be used at habitation areas on rural roads. It will give a good aesthetic view as compare to cast in situ concrete roads. As regard of maintenance point is concern the damaged blocks can be easily replaced where as in case of concrete roads the replacement of damaged concrete is difficult. The further analysis & monitoring can be categories under scope for future work.

### Scope for Future work

If these blocks are used at habitation areas of rural roads then their construction cost, maintenance cost & other easiness, difficulties can be visualized for future use in different situations.

As these are precast blocks, the research activities can be easily done at work sheds even at the time when the construction work is under progress.

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