CONCRETE BLOCK PAVING

Technical note for steep slopes

A walk-over in cost, looks and durability for Concrete Block Paving

CONCRETE MANUFACTURERS ASSOCIATION

Quality cast in concrete

1. CONSTRUCTION OF STEEP SLOPES

The construction of roads on steep slopes poses particularly interesting challenges for road engineers. The horizontal (inclined) forces exerted on the road surface are severely increased due to traffic accelerating (uphill), braking (downhill) or turning. These horizontal forces cause distress in most conventional pavements, resulting in rutting and poor riding quality.; Experience has shown that concrete block paving (cbp) performs well under such severe conditions.

Although cbp performs well on steep slopes, there are certain considerations that must be taken into account during the design and construction of the pavement:

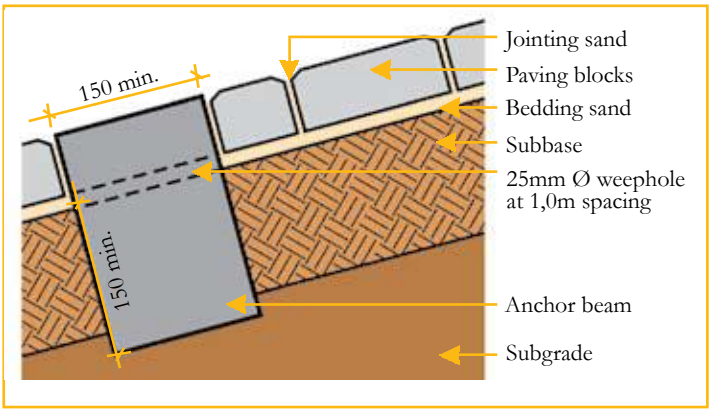

Figure 1 – Typical section through anchor beam showing dimensions

1.1 Anchor beam

It is common practice to construct edge restraints (kerbing and anchor beams) along the perimeter of all paving to contain the paving and prevent horizontal creep and subsequent opening of joints. Due to the steepness of the slope, the normally vertical traffic loading will have a surface component exerted on the blocks in a downward direction. This force is aggravated by traction of accelerating vehicles up the hill and breaking of vehicles down the hill. If uncontained, these forces will cause horizontal creep of the blocks down the slope, resulting in opening of joints at the top of the paving. An anchor beam at the lower end of the paving is necessary to prevent this creep. Figure 1 shows a typical section through an anchor beam. Anchor beams should be used on roads where the slope is greater than 12%. Between 8% and 12% anchor beams should be used at the discretion of the engineer.

1.2 Spacing and position of anchor beams

There are no fixed rules on the spacing of anchor beams (if any) above the essential bottom anchor beams. This should be determined by the engineer. However the following can be used as a guideline:-

Slope	Spacing of anchor beams
12%	30m
15%	20m
20%	15m

See figure 2 for details

It is standard practice when laying cbp to start at the lower end and to work upwards against the slope. This practice will ensure that if there is any movement of blocks during the laying operation, it will help to consolidate the blocks against each other, rather than to open the joints. If one is constructing a road over undulating topography, it is suggested that one begins at the low point of the dip and work away in both directions simultaneously. No anchor beam is required at the low point.

1.3 Construction of anchor beam

For ease of construction, it is recommended that the blocks are laid continuously up the gradient. Thereafter, two rows of blocks are uplifted in the position of the beam, the subbase excavated to the required depth and width and the beam cast, such that the top of the beam is 7-10mm lower than the surrounding block work. This allows for settlement of the pavers. This method of construction will ensure that the anchor beam interlocks, with the pavers and eliminates the need to cut small pieces of block.

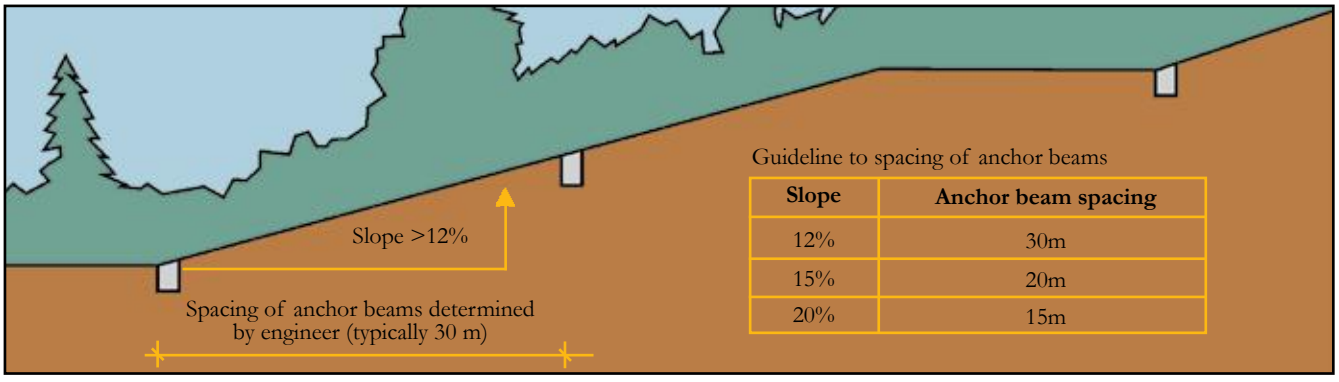

Figure 2 – Spacing of anchor beams

1.4 Subbase drainage

As with other pavement surfaces, rain water can penetrate through the joints in the cbp. With steep slopes, the tendency is for this water to travel down the slope in the bedding sand layer and accumulate at the anchor beam. If unattended, this water can lead to softening of the subbase, settlement, and possible pumping. To eliminate this problem, it is important to provide subsoil drainage, immediately upstream of the anchor beam. Figure 3 shows two methods of achieving this. In addition weepholes should be cast into the anchor beam.

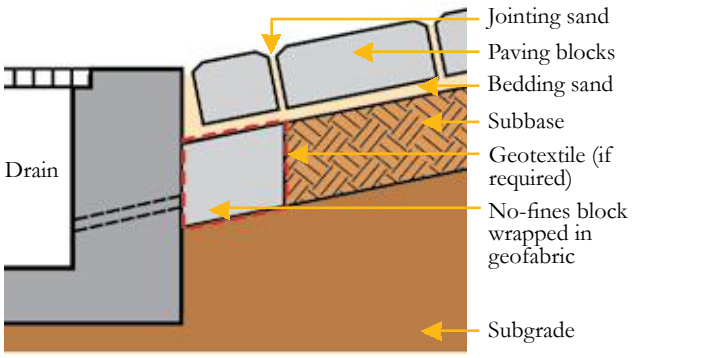

Figure 3 a – No fines block in subbase layer

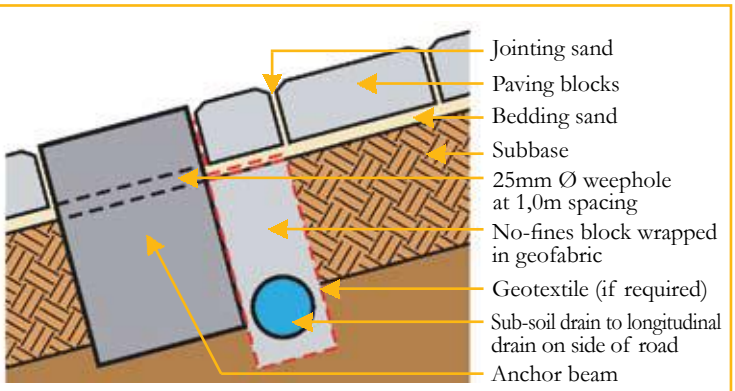

Figure 3 b – Subsoil drain drawing bedding sand water to side drain

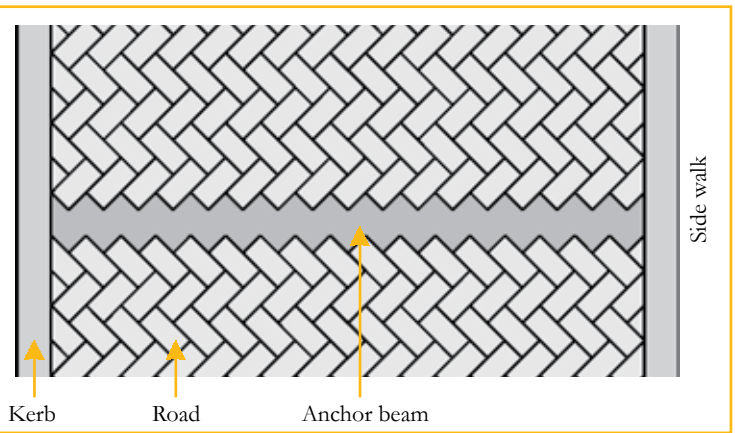

Figure 4 – Herringbone 45^{0} to the kerbing.

1.5 Surface drainage

Due to the steep slopes, the storm water, which flows down the road during a storm can attain relatively high velocities. If uncontrolled, this flow can cause erosion of the jointing sand and result in the paving losing its integrity. The following are a number of precautionary measures, which can be used to prevent this erosion:

- Blocks should be laid in herringbone pattern at 45^{0} to the kerbing. See figure 4. Not only does this practice encourage the flow of water to the side channels, but it maximises the arching action of the paving against the kerb;
- If the blocks are to be laid in stretcher bond, then it is important that the lines are normal to the direction of flow of water;
- The road should have a reasonable camber or cross fall (slope>3%) to ensure that the stormwater is diverted to the gutters and does not run down the centre of the road. Blocks should be laid such that the finished level is approximately 5mm above the gutter to prevent ponding along the edges;
- Interlocking blocks (type S-A) should be used as the shape prevents flow build up along the joints, which reduces creep or surface movement;
- 80mm thick blocks have an advantage over 60mm, as the additional depth of joint mitigates against wash out;
- Care should be taken to ensure that joint widths are within specification;
- The gradings of bedding sand and jointing sand shall be as in SANS 1200 MJ. If possible, ensure that the jointing sand contains a little clay;
- Sealing of the joints with a proprietary sealer.

1.6 Top edge maintenance

As a result of the forces described previously, there could be a small amount of horizontal creep and sliding of the blocks due to the horizontal consolidation of the jointing sand. This could result in an opening up of the top edge joint.

Although this gap does not affect the structural integrity of the pavement, it does need addressing as it can lead to ingress of water. Typically, the pavement should be monitored after 3-6 months, and if a joint has opened up, it should be filled with jointing sand or a bitumen sealant.

Photograph 4 – Upper Rhine Road

Photograph 6 – Avenue Charmante

Photograph 8 – Upper Rhine Road - section still to be rehabilitated

CREDITS
Client: Cape Town Municipality
Contractor: Cape Town Municipality, Roads Department, Ebenezer
CBP Supplier: Inca (Cape)

Photograph 5 – Anchor beam in Avenue Charmante

Photograph 7 – Avenue Chamante

Photograph 9 – Upper Rhine Road - after rehabilitated

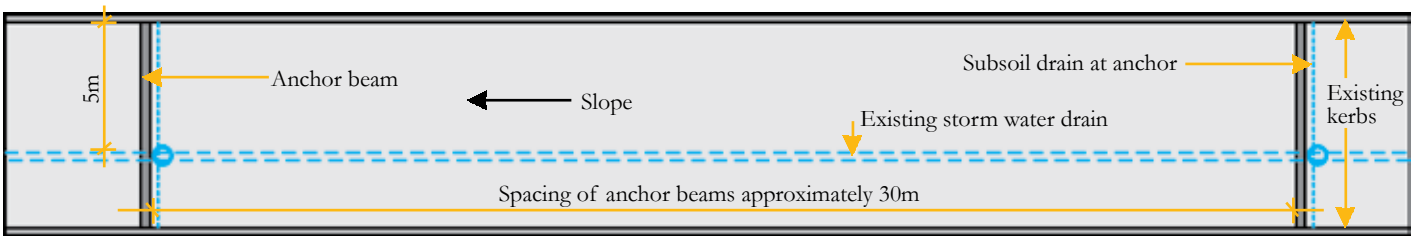

Figure 5 – Plan view of Boundary Road, Greenpoint

2. CAPE TOWN – CASE STUDY

Of particular interest are a number of very steep roads in Cape Town, which were rehabilitated using concrete block paving. The roads which were paved are given in Table 1.

A concrete slab pavement was considered as an alternative, but concrete block paving was chosen for the following reasons:

- Concrete block paving can be uplifted and replaced relatively easily and so makes maintenance of underground services a relatively easy operation.
- Concrete block paving can be opened to traffic immediately upon completion and requires no curing.

Road	Suburb	Slope
Boundary Road	Greenpoint	23%
Avenue Charmante	Fresnaye	18%
Upper Rhine Road	Seapoint	22%

Table 1 – Roads in Cape Town repaved with cbp

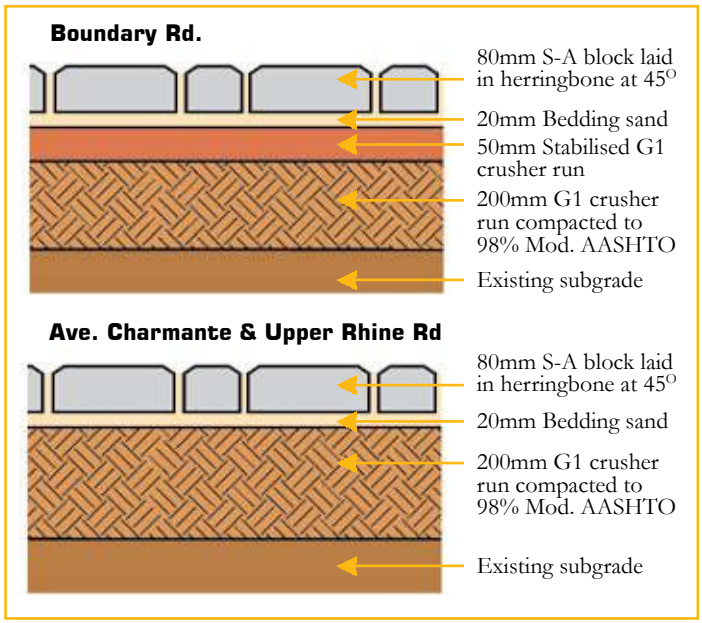

Figure 6-Pavement layers of Cape Town roads under review

Photograph 1 – Anchor beam, showing gap due to creep of blocks immediately downside of anchor beam

Photograph 2 – Boundary Road after rehabilitation

Photograph 3 – Anchor beam at bottom of Upper Rhine Road

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