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DRAFT ZIMBABWE SPECIFICATION FOR

PRECAST CONCRETE WITH UP TO 50 % COMPOSITE PLASTIC AGGREGATE



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All comments should be sent to the Committee Secretary **Ms Ennie Pindura** at the address shown below.

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## Foreword

This Zimbabwe Standard ZWS 1141:2025: Precast concrete with up to 50 % composite plastic aggregate, is based on Kenya Standard KS 2913:2020. The standard was prepared by technical committee BC 048 – Concrete, Reinforced Concrete and Pre-stressed Concrete, which falls under the Building and Civil Engineering Standards Sector.

This standard makes reference to the following publications:

ZWS 187 : Specification for concrete roofing tiles

ZWS 1140 : Aggregates from synthetic plastic wastes sources for concrete

## Introduction

The need to clean the environment of postconsumer plastics wastes as a climate change mitigation measure and carbon footprint reduction motivated the development of the precast concrete with composite plastic aggregates plastic composite standard, intended for the construction of low-speed roads, domestic driveways and parking and other paved surfaces subjected to all categories of static and vehicular loading and pedestrian traffic

ZIMBABWE STANDARD SPECIFICATION

FOR

PRECAST CONCRETE WITH UP TO 50 % COMPOSITE PLASTIC AGGREGATE

## 1. Scope

This draft Zimbabwe Standard specifies requirements for precast concrete composite with up 50 % plastic aggregate.

**Note**. The titles of the publications referred to in this standard are listed in the Foreword.

## 2. Terms and Definitions

For the purpose of this draft Zimbabwe Standard the following terms and definitions shall apply:

2.1 **Composite**
Material made up of two or more materials, one of which is a matrix and the other one a reinforcement material.

2.2 **Compressive strength**
Average crushing strength of a sample of 12 precast concrete composite product.

**2.3** **Matrix**
Binding material with cementous properties.

2.4 **Nominal Size**
Precast concrete composite products, normally expressed in terms of dimensions of length, width and thickness, specified for its manufacture, to which its actual size should conform within specified deviations

**2.5** **Plan area**
Area bounded by those faces that are approximately normal to the wearing surface

**2.6** **Plastic Composite**
A precast concrete composite made up of a thermoplastic material (matrix), rivers sand or washed sand and particulate reinforcement material.

**2.7** **Precast Concrete Composite Product**
Concrete components made by casting concrete into reusable molds which are then cured in a controlled environment before being moved to the destination or site, such as, wall panels, pavers, domestic building materials, light materials and any other related building products.

**2.8 Reinforcement**
The fibrous or particulate material offering mechanical strength to the composite.

**2.9 Thermoplastic**
A polymer which repeatedly flows when heated to its melting temperature and solidifies when cooled.

**2.10 Wearing**
Surface(s) of a precast concrete composite designed to be laid uppermost and to be exposed to traffic use on a day-to-day basis.

## 3 Designation, Sizes and Tolerances

**3.1 Designation and Sizes**
Precast concrete composite products shall have a work size thickness of not less than 50 mm (see Table 1). A chamfer around the in width or depth shall be permitted. All arises shall be of uniform shape.

**3.2 Tolerances**

3.2.1 The maximum dimensional deviations from the stated nominal sizes for precast concrete composite products measured in accordance with Clause A.1 shall be as follows:

- Length ± 2 mm;

- Width ± 2 mm; and

- Thickness ± 2 mm.

3.2.2 For precast concrete composite products assessed in accordance with Clause A.2, each side shall be perpendicular to the wearing surface and the opposite face.

**Note**. A side is considered to be perpendicular to the brick faces if the difference between the two readings measured as described in Clause A.2 does not exceed 2 mm.

3.2.3 Where a precast concrete composite product includes profiled sides, the profile shall not deviate from the manufacturer's specification by more than 2 mm.

## 4. Testing

**4.1 Heat resistance**
Use Thermogravimetric Analysis (TGA).

The precast concrete composite product shall be heat resistant and meet the requirements set in Table 1 after being subjected to an oven test.

**Table 1 Oven Test Result**

Commented [EP1]: To be finalised after test results

| Temperature, ºC | Remark |
|---|---|
| 50 | No change |
| 100 | No change |
| 150 | Melts |

4.2 **Chemical resistance**

The precast concrete composite product shall be resistant to common solvents found in industries such as thinners, acetone, turpentine, ketones, aldehydes, acids and alkaline substance for when accidental chemical spillages happen during the product service life.

Solubility tests shall be conducted on these products by exposing them to commonly known solvents.

## 5. Compressive Strength and Grading

Precast concrete composite product shall be graded as from light duty (L) to heavy duty (H). The respective compressive strength for the grade is outlined in Table 2, the thicknesses and the recommended areas of application are also specified in Table 2.

Specimens for the compressive strength test are sampled in accordance with Clause 7 and tested as described in Appendix B.

**Table 2 – Grading Criteria and Application of Precast Concrete composite Products**

| S/N | Grade | Nominal thickness, mm | Compressive strength, N/mm² | Application |
|---|---|---|---|---|
| i. | Light duty (L) | 50 | 9 - 15 | Precast concrete composite products |
| ii. | Heavy duty (H) | 50 | 16 - 25 | Precast concrete composite products |

**Note.** It is advisable to apply higher strength paving blocks to areas of high abrasion activity e.g. in corners where vehicles are likely to skid.

## 6. Abrasion Test

The abrasion resistance of precast concrete composite products should be determined as per the method given in Appendix C. The limits of the test results may be specified, which should be complied with by the manufacturer.

## 7. Sampling

The following sampling procedure shall be used for the compressive strength test.

a) Before laying precast concrete composite products, divide each designated section, comprising not more than 5 000 of the product, in a consignment into eight approximately equal groups. Clearly mark all samples at the time of sampling in such a way that the designated section or part thereof and the consignment represented by the sample are clearly defined. Take two samples from each group.

b) Dispatch the sample to the test laboratory, taking precautions to avoid damage to the precast concrete composite product in transit. Each sample shall be accompanied by a certificate from the person responsible for taking the sample stating that sampling was carried out in accordance with this standard.

c) Protect the precast concrete composite product from damage and contamination until they have been tested. Carry out any tests as soon as possible after the sample has been taken.

## 8. Marking

The following particulars relating to precast concrete composite product made in accordance with this standard shall be indicated clearly on the delivery note, invoice, manufacturer's or supplier's certificate or brochure supplied with the consignment of the product:

a) the name, trade mark or other means of identification of the manufacturer;

b) the number of this standard;

c) type of precast concrete composite product;

d) strength grade;

e) nominal dimensions: and

f) Certification mark of the Standards Association of Zimbabwe (if used).

# Appendix A

## Measurement of Dimensions and Plan Area

This appendix forms part of the requirements of this standard

A.1 **Determination of Thickness, Length and Width**

A.1.1 ***Apparatus***

A.1.1.1 *Steel calipers*

A.1.1.2 *Steel rule***,** capable of measuring up to 300 mm to an accuracy of 0.5 mm

A.1.2 ***Procedure***

A.1.2.1 *Thickness*. Measure the thickness of the product at four representative positions to the nearest 1 mm, using steel calipers (A.1.1.1). Report the value of each measurement to the nearest 1 mm.

A.1.2.2 *Length and width*. Measure the length and width across two opposite faces of the block to the nearest 1 mm using steel calipers (A.1.1.1) or a steel rule (A.1.1.2). Two representative positions shall be used for length measurement and three positions for width measurement. Report the value of each measurement to the nearest 1 mm.

**Note.** Care should be taken to measure each product in a sample using the same representative positions.

A.2 **Determination of squareness**

A.2.1 ***Apparatus***

A.2.1.1 *Profiled template or an engineer's square*

A.2.1.2 *Feeler gauges*

A.2.2 ***Procedure***. With the stock of the square or the profiled template (A.2.1.1) in contact with the top or bottom face of the product, bring the blade into contact with the side of the block. Carry out the test by measuring with the feeler gauges (A.2.1.2) the clearance, if any, between the square or profiled template and the side of the product at points 10 mm from each top and bottom edge. Take measurements at six different points spaced approximately equally around the product.

A.3 **Determination of Plan Area**

A.3.1 ***Rectangular*** precast concrete composite products. Calculate the plan area by multiplying the length by the width, or by using the method described in A.3.3.

A.3.2 ***Shapes other than rectangles***

A.3.2.1 *Apparatus*

A.3.2.1.1 *Balance*, capable of weighing 100 g to an accuracy of 0.01 g

A.3.2.1.2 *Sheets of thin cardboard***,** of uniform thickness

A.3.2.1.3 *Sharp scissors*

A.3.2.1.4 *Steel rule*, marked in graduations of 0.5 mm

A.3.3 ***Measurement of plan area***. Place the product, wearing surface uppermost, on the cardboard (A.3.2.1.2) and trace around its perimeter with a pencil. Cut out the shape accurately and weigh it to the nearest 0.01 g, using the balance (A.3.2.1.1).

Weigh a rectangle measuring 200 mm x 100 mm, cut accurately from the same cardboard to the nearest 0.01 g.

Calculate the plan area of the precast concrete composite product A, in mm² using the following equation:

$$A_S = \frac{20\,000\, m_s}{m_r}$$

where,

$m_r$ is the mass of the 200 mm x 100 mm cardboard rectangle (in g);calculate the plan area to the nearest 10 mm²; and

$m_s$ is the mass of the cardboard shape matching the product (in g).

# Appendix B

## Determination of Compressive Strength

This appendix forms part of the requirements of this standard

B.1 **Apparatus**

B.1.1 ***Compression testing machine***

B.1.2 ***Cypress*****,** pine or softwood plywood packing, 4 mm thick and larger than the specimen by a margin of at least 5 mm at 11 points.

B.2 **Procedure**

Measure the dimensions of each product before storing it in water and calculate the plan area, as described in Appendix A. Test a sample of bricks taken as described in Clause 6 after storing them for 24 h ± 4 h in water maintained at a temperature of 20 ºC ± 5 ºC.

Wipe clean the platens of the testing machine. Remove any loose grit or other material from the contact faces of the product. Place timber packing between the upper and lower faces of the product and the machine platens. Use fresh packing for each product tested.

Place the product in the machine with the wearing surface in a horizontal plane and in such a way that the axes of the product are aligned with those of the machine platens.

Apply the load without shock and increase it continuously at a rate of 15 ± 3 N/(mm² min) until no greater load can be sustained by the paving product or delamination occurs. Record the maximum load applied to the product.

B.3 **Calculation of Compressive Strength**

Calculate the crushing strength of each product to the nearest 0.1 N/mm² by dividing the maximum load by the plan area and multiplying by the appropriate factor from Table 3. Calculate the compressive strength, expressing the value to the nearest 1 N/mm².

**Table 3 – Thickness and chamfer correction factors for compressive strength**

| Nominal size thickness, mm | Correction factors | |
|---|---|---|
| | Plain product | Chamfered product |
| 50.60 | 1.00 | 1.06 |
| 80 | 1.12 | 1.18 |

# Appendix C

## Method for determination of abrasion resistance

This appendix forms part of the requirements of this standard

C.1 **Apparatus**
The abrasion testing machine shall be the same as described (see Figure 1).

C.2 **Specimens**

C.2.1 Square-shaped specimens measuring 71.0 mm ± 0.5 mm shall be cut from the product specimens selected as per the sampling procedure in Clause 7 and as per the number of specimens mentioned in Clause 7. The contact face and the opposite face of the specimen shall be parallel and flat. For determining the reduction in thickness as described in C.4, the opposite face shall, if appropriate, be ground parallel or otherwise machined to be parallel.

C.2.2 For testing dry specimens, the specimens shall be dried to constant mass at a temperature of 105 ±5 ºC.

C.2.3 For testing wet/saturated specimens; the specimens shall be immersed in water for 7 d and wiped with a damp artificial sponge prior to each weighing (see C.3) so that all specimens appear equally damp.

C.3 **Procedure**

C.3.1 The density of the specimen, PR shall be determined nearest to 0.1 g. The weight of the specimen shall be noted to nearest 0.1 g both prior to the abrasion test and after every four cycles (see C.4).

C.3.2 In the case of two-layer specimens, the density of specimens taken separately from the wearing layer shall be determined.

C.3.3 The grinding path of the disc of the abrasion testing machine shall be evenly strewn with 20 g of the standard abrasive powder as per ZWS 187. The specimen shall be fixed in the holding device such that the testing surface faces the grinding disc. The specimen shall be centrally loaded with 294 +3 N.

C.3.4 The grinding disc shall be run at a speed of 30 rpm. The disc shall be stopped after one cycle of 22 revolutions. The disc and contact face of the specimen shall be cleaned of abrasive powder and debris. The specimen shall be turned 90° in the clockwise direction and 20 g of abrasive powder shall be evenly strewn on the testing track before starting the next cycle.

C.3.5 When testing wet/saturated specimens, prior to each cycle, the track shall be wiped with a lightly damp artificial sponge and moistened before being strewn with the abrasive powder. From the start of the test, arrangements shall be made for drip-wetting of the central portion of the track, about 30 mm from the specimen (opposite to the direction of motion of the disc), by supplying water drops at the rate of 180 to 200 drops (13 ml) per minute. During this test, it should be ensured that the abrasive powder continuously returns to the effective area of the track.

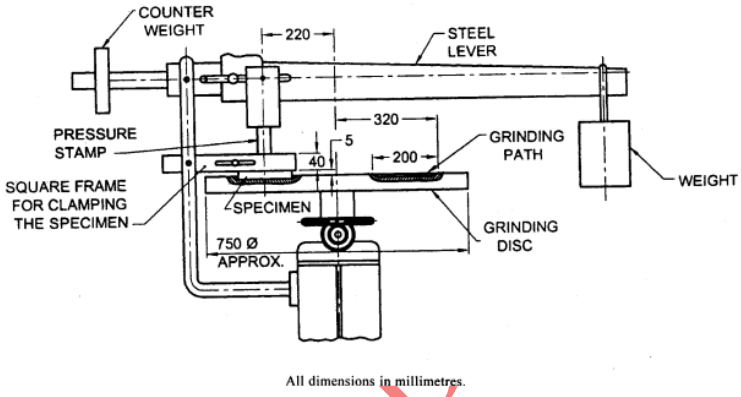


**Figure 1 — Abrasion testing machine**

C.3.6 The test cycle shall be repeated 16 times; the specimen being turned 90° in the clockwise direction and spreading of 20 g of abrasive powder on the testing track after each cycle.

C.4 **Calculation**

The abrasive wear of the specimen after 16 cycles of testing shall be calculated as the mean loss in specimen volume, *V*, from the equation:

$$\Delta V = \frac{\Delta m}{PR}$$

where,

ΔV = loss in volume after 16 cycle, in mm²;

Δm = loss in mass after 16 cycles, in g; and

PR = density of the specimen, or in the case of two-layer specimens, the density of the wearing layer, in g/ mm³

C.5 **Report**

The abrasive wear shall be reported to the nearest whole number of 1 000 $mm^3$ per 5 000 $mm^2$.