



# COMPRESSIVE STRENGTH OF HYDRAULICALLY BOUND MIXTURES

BS EN 13286-41:2003

Job number: 65045202  
Location of testing: AECOM, Nottingham, Laboratory  
Project title: Beaulieu Park – RDR Pavement Construction

Date tested: Various  
Date reported: 30 October 2017  
Tested by: GLC

AECOM reference:	C1M1_1	C1M1_2	C1M1_3
Mix design:	4.0% Cement 4.5% Water	4.0% Cement 4.5% Water	4.0% Cement 4.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	148	150	151
Specimen length (mm):	158	153	155
Specimen mass in water (g):	3788.3	3695.9	3638.2
Specimen mass damp in air (g):	6566.4	6359.3	6444.0
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	28 days in air, @ 20 °C	28 days in air, @ 20 °C	28 days in air, @ 20 °C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2360	2380	2290
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	3.75	2.90	3.18
Mean Compressive strength (N/mm <sup>2</sup> ):	3.28		
Retained Strength:	n/a		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

Test was carried out in accordance with BS EN 13286-41:2003 and Volume 1 - Specification for Highway Works, Series 800, Clause 880.4

Checked by:-

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Date tested: Various  
Date reported: 30 October 2017  
Tested by: GLC

AECOM reference:	C1M1_4w	C1M1_5w	C1M1_6w
Mix design:	4.0% Cement 4.5% Water	4.0% Cement 4.5% Water	4.0% Cement 4.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	150	151	151
Specimen length (mm):	156	156	156
Specimen mass in water (g):	3794.4	3842.5	3727.6
Specimen mass damp in air (g):	6533.3	6674.0	6411.9
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	14 days in air, followed by 14 days in water, @ 20°C	14 days in air, followed by 14 days in water, @ 20°C	14 days in air, followed by 14 days in water, @ 20°C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2380	2350	2380
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	4.54	3.67	2.95
Mean Compressive strength (N/mm <sup>2</sup> ):	3.72		
Retained Strength:	114%		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

'w' denotes soaked specimen

Test was carried out in accordance with BS EN 13286-41:2003 and Volume 1 - Specification for Highway Works, Series 800, Clause 880.4

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AECOM reference:	C1M2_7	C1M2_8	C1M2_9
Mix design:	4.0% Cement 6.5% Water	4.0% Cement 6.5% Water	4.0% Cement 6.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	151	152	151
Specimen length (mm):	157	151	156
Specimen mass in water (g):	3842.1	3570.3	3777.2
Specimen mass damp in air (g):	6651.9	6257.3	6540.7
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	28 days in air, @ 20 °C	28 days in air, @ 20 °C	28 days in air, @ 20 °C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2360	2320	2360
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	2.40	3.57	3.41
Mean Compressive strength (N/mm <sup>2</sup> ):	3.13		
Retained Strength:	n/a		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

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AECOM reference:	C2M2_10	C2M2_11	C2M2_12
Mix design:	4.0% Cement 6.5% Water	4.0% Cement 6.5% Water	4.0% Cement 6.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	150	150	151
Specimen length (mm):	156	159	150
Specimen mass in water (g):	3571.0	3703.6	3403.2
Specimen mass damp in air (g):	6245.1	6436.1	5951.9
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	28 days in air, @ 20°C	28 days in air, @ 20°C	28 days in air, @ 20°C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2330	2350	2330
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	2.63	1.67	1.67
Mean Compressive strength (N/mm <sup>2</sup> ):	1.99		
Retained Strength:	n/a		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

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AECOM reference:	C2M1_17	C2M1_18	C2M1_19
Mix design:	5.0% Cement 4.5% Water	5.0% Cement 4.5% Water	5.0% Cement 4.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	151	151	152
Specimen length (mm):	153	153	154
Specimen mass in water (g):	3608.2	3505.0	3604.9
Specimen mass damp in air (g):	6301.0	6132.8	6305.2
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	28 days in air, @ 20 °C	28 days in air, @ 20 °C	28 days in air, @ 20 °C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2340	2330	2330
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	2.26	2.75	5.41* (not used in average)
Mean Compressive strength (N/mm <sup>2</sup> ):	2.51		
Retained Strength:	n/a		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

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AECOM reference:	C2M1_24w	C2M1_25w	C2M1_26w
Mix design:	5.0% Cement 4.5% Water	5.0% Cement 4.5% Water	5.0% Cement 4.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	152	151	152
Specimen length (mm):	158	156	160
Specimen mass in water (g):	3723.8	3549.5	3741.1
Specimen mass damp in air (g):	6511.4	6177.2	6532.6
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	14 days in air, followed by 14 days in water, @ 20°C	14 days in air, followed by 14 days in water, @ 20°C	14 days in air, followed by 14 days in water, @ 20°C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2330	2350	2340
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	3.44	2.55	3.12
Mean Compressive strength (N/mm <sup>2</sup> ):	3.04		
Retained Strength:	121.2%		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

'w' detones soaked specimen

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AECOM reference:	C3M2_21	C3M2_22	C3M2_23
Mix design:	6.0% Cement 6.5% Water	6.0% Cement 6.5% Water	6.0% Cement 6.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	152	152	152
Specimen length (mm):	156	153	153
Specimen mass in water (g):	3760.3	3709.3	3595.8
Specimen mass damp in air (g):	6575.8	6484.0	6301.5
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	28 days in air, @ 20 °C	28 days in air, @ 20 °C	28 days in air, @ 20 °C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2330	2330	2320
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	3.13	2.81	3.53
Mean Compressive strength (N/mm <sup>2</sup> ):	3.16		
Retained Strength:	n/a		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

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Date tested: Various  
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AECOM reference:	C3M1_27	C3M1_28	C3M1_29
Mix design:	6.0% Cement 4.5% Water	6.0% Cement 4.5% Water	6.0% Cement 4.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	151	150	151
Specimen length (mm):	157	153	154
Specimen mass in water (g):	3588.3	3412.0	3442.3
Specimen mass damp in air (g):	6294.5	6049.0	6045.1
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	28 days in air, @ 20°C	28 days in air, @ 20°C	28 days in air, @ 20°C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2320	2290	2320
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	1.80	2.35	2.03
Mean Compressive strength (N/mm <sup>2</sup> ):	2.06		
Retained Strength:	n/a		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

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Date tested: Various  
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AECOM reference:	C3M1_30w	C3M1_31w	C3M1_32w
Mix design:	6.0% Cement 4.5% Water	6.0% Cement 4.5% Water	6.0% Cement 4.5% Water
Shape of specimen:	Cylinder	Cylinder	Cylinder
Method of specimen manufacture:	Compaction of each specimen was carried out using a vibrating hammer in accordance with BS EN 13286-51:2004.		
Specimen diameter (mm):	151	151	151
Specimen length (mm):	153	151	157
Specimen mass in water (g):	3390.7	3190.9	3429.8
Specimen mass damp in air (g):	5990.0	5638.1	6048.6
Water Temperature	20	20	20
Condition of specimen at receipt for storage:	Good	Good	Good
Method of curing/storage:	14 days in air, followed by 14 days in water, @ 20 °C	14 days in air, followed by 14 days in water, @ 20 °C	14 days in air, followed by 14 days in water, @ 20 °C
Method of adjustment:	n/a	n/a	n/a
Bulk density of specimen at the time of test (kg/m <sup>3</sup> ):	2300	2300	2310
Condition of specimen at time of weighing/test:	Good	Good	Good
Age of specimen at time of test:(Days)	28 Days	28 Days	28 Days
Type of failure:	Satisfactory	Satisfactory	Satisfactory
Compressive strength (N/mm <sup>2</sup> ):	1.87	1.29* (not used in average)	1.52
Mean Compressive strength (N/mm <sup>2</sup> ):	1.70		
Retained Strength:	82.28%		

Calculations :-

$$R_c = \frac{F}{A_c}$$

where:

$R_c$  is the compressive strength of the specimen of hydraulically bound mixtures, in newtons per square millimetre (N/mm<sup>2</sup>);

$F$  is the maximum force sustained by the specimen of hydraulically bound mixtures, in newtons (N);

$A_c$  is the cross section area of the specimen, in square millimetres (mm<sup>2</sup>)

'w' denotes soaked specimen

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