



(RESEARCH ARTICLE)



MIX DESIGN AND PROPORTIONAL REQUIREMENTS FOR THE PRODUCTION OF C30/37 INTERLOCKING CONCRETE TILES

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ABSTRACT

The inadequate application of standard methods for the design and production of interlocking concrete tiles can result in poor-quality tiles and premature pavement failure. This study investigated suitable concrete mix proportions for producing interlocking concrete tiles with a target characteristic strength of 30 N/mm². River sand was used as the fine aggregate and 10 mm granite chippings as the coarse aggregate. The fine aggregate was within Zone 2 and had a specific gravity of 2.66, while the coarse aggregate had a specific gravity of 2.71. Three trial mixes were developed using SCALE 149 software. The cement:water:fine aggregate:coarse aggregate proportions were 275:160:790:1240 for Mix 1, 290:170:780:1225 for Mix 2, and 320:190:760:1195 for Mix 3. Five specimens were produced for each mix and cured for 28 days before compressive-strength testing. The mean strengths were 37.88, 38.52 and 36.26 N/mm² for Mixes 1, 2 and 3, respectively. Sample standard deviations were 2.747, 2.762 and 3.866 N/mm², respectively. Using the characteristic-strength relationship adopted in this study, $f_{ck} = \bar{x} - 1.64s$, the corresponding characteristic strengths were 33.37, 33.99 and 29.92 N/mm². Mix 2 produced the highest strength, while Mix 1 provided a lower-cement-content alternative that still exceeded the 30 N/mm² target. Mix 3 was marginally below the target based on the recalculated characteristic strength. The results indicate that Mix 2 is preferable where compressive strength is the primary criterion, whereas Mix 1 warrants consideration where reduced cement content is prioritized.

Keywords: Interlocking Concrete Tiles; Mix Design; Compressive Strength; Characteristic Strength; Water-Cement Ratio; Concrete Pavement.

1 INTRODUCTION

Interlocking concrete tiles are widely used for pedestrian areas, driveways, residential pavements and other hardstanding applications. Their performance depends on the quality of the concrete, geometric characteristics of the units and the structural arrangement of the pavement. Strength and durability are therefore important considerations in the production of interlocking paving units.

The quality of an interlocking concrete tile is strongly influenced by the proportions of cement, water and aggregates used in its manufacture. In particular, the water-to-cement ratio affects the development of concrete strength. Inadequate proportioning may produce units with insufficient strength and may contribute to premature pavement deterioration.

Previous work has considered the performance of interlocking pavement systems and the use of concrete paving units in pavement construction [1–4]. However, selection of an appropriate local mix proportion remains important because aggregate characteristics, production practices and material availability vary between locations.

The objective of this study was to investigate three concrete mix proportions for the production of C30/37 interlocking concrete tiles and to compare their 28-day compressive strengths, standard deviations and calculated characteristic strengths. The study also identifies a mix with a relatively low cement content that may be considered for economical production.

2 MATERIALS AND METHODS

2.1 Materials

River sand was used as the fine aggregate and 10 mm granite chippings were used as the coarse aggregate. The fine aggregate was reported to fall within Zone 2 and had a specific gravity of 2.66. The coarse aggregate had a specific gravity of 2.71.

2.2 Mix Design

Three concrete mixes were designed for a target characteristic strength of 30 N/mm² using SCALE 149 software. The design considered a slump range of 10–30 mm and the aggregate properties obtained from the preliminary material tests. The resulting mix proportions are presented in Table 1.

Table 1: Three Concrete Mix Proportions

Mix	Cement (kg/m ³)	Water (kg/m ³)	Fine aggregate (kg/m ³)	Coarse aggregate (kg/m ³)	w/c ratio
Mix 1	275	160	790	1240	0.580
Mix 2	290	170	780	1225	0.587
Mix 3	320	190	760	1195	0.594

Note: The Mix 3 fine-aggregate quantity is reported as 760 kg/m³ in the mix-proportion statement used for this revision. This value should be verified against the original SCALE 149 output before final publication.

2.3 Specimen Preparation and Curing

Bone-shaped concrete specimens were cast using prepared moulds. The moulds were cleaned and lubricated with a thin coat of diesel. Concrete was placed in layers and each layer was compacted by tamping 25 times. After 24 hours, the specimens were demoulded and cured for 28 days. Five specimens were prepared for each mix proportion.

2.4 Compressive-Strength Test

After 28 days of curing, the specimens were tested using a 200 kN-capacity compression testing machine. The maximum load sustained by each specimen was recorded and used to calculate compressive strength. The original experimental work cited BS EN 12390-3:2002; however, that edition has been withdrawn. The current BSI edition is BS EN 12390-3:2019. [\[cite?turn0search0?turn0search10\]](#)

For the purpose of this manuscript, the reported experimental procedure and results were retained. The exact loading rate, specimen dimensions and machine verification details were not provided in the source manuscript and should be added from the laboratory records if available.

2.5 Statistical Analysis

Compressive strength was calculated as the maximum load divided by the loaded cross-sectional area:

$$f_c = P/A$$

where f_c is the compressive strength (N/mm²), P is the maximum applied load (N), and A is the loaded cross-sectional area (mm²).

The arithmetic mean was calculated as:

$$\bar{x} = \Sigma x/n$$

The sample standard deviation was calculated as:

$$s = \sqrt{[\Sigma(x - \bar{x})^2/(n - 1)]}$$

The characteristic-strength calculation used in the original analysis was expressed as:

$$f_{ck} = \bar{x} - 1.64s$$

The coefficient 1.64 is retained here because it is the relationship implicit in the characteristic-strength values reported for Mixes 1 and 2 in the source manuscript. It should be explicitly justified by the design standard or methodology used by the researcher before publication.

3 RESULTS

Table 2: Individual compressive-strength results for Mix 1

S/N	Mass (g)	Density (kg/m ³)	Load (kN)	Area (m ²)	Strength (N/mm ²)
1	3227	2199.44	862.73	0.0253	34.1
2	3503	2387.27	931.04	0.0253	36.8
3	3588	2445.78	1017.06	0.0253	40.2
4	3595	2450.56	946.22	0.0253	37.4
5	3466	2362.23	1034.77	0.0253	40.9

Table 3: Individual compressive-strength results for Mix 2

S/N	Mass (g)	Density (kg/m ³)	Load (kN)	Area (m ²)	Strength (N/mm ²)
1	3504	2387.90	877.91	0.0253	34.7
2	3454	2353.82	951.28	0.0253	37.6
3	3527	2403.57	1032.24	0.0253	40.8
4	3599	2452.64	958.87	0.0253	37.9
5	3798	2588.25	1052.48	0.0253	41.6

Table 4: Individual compressive-strength results for Mix 3

S/N	Mass (g)	Density (kg/m ³)	Load (kN)	Area (m ²)	Strength (N/mm ²)
1	3700	2521.47	984.17	0.0253	38.9
2	3475	2368.13	799.48	0.0253	31.6
3	3357	2287.72	898.15	0.0253	35.5
4	3611	2460.81	1044.89	0.0253	41.3
5	3345	2279.54	860.20	0.0253	34.0

Table 5: Standard-deviation calculation for Mix 1

S/N	Strength (N/mm ²)	Mean $\bar{x}$	Deviation	Squared deviation
1	34.1	37.88	-3.78	14.2884
2	36.8	37.88	-1.08	1.1664
3	40.2	37.88	2.32	5.3824
4	37.4	37.88	-0.48	0.2304
5	40.9	37.88	3.02	9.1204
Total	189.4	37.88		30.1880

Table 6: Standard-deviation calculation for Mix 2

S/N	Strength (N/mm ²)	Mean $\bar{x}$	Deviation	Squared deviation
1	34.7	38.52	-3.82	14.5924
2	37.6	38.52	-0.92	0.8464
3	40.8	38.52	2.28	5.1984
4	37.9	38.52	-0.62	0.3844
5	41.6	38.52	3.08	9.4864
Total	192.6	38.52		30.5080

Table 7: Standard-deviation calculation for Mix 3

S/N	Strength (N/mm ²)	Mean $\bar{x}$	Deviation	Squared deviation
1	38.9	36.26	2.64	6.9696
2	31.6	36.26	-4.66	21.7156
3	35.5	36.26	-0.76	0.5776
4	41.3	36.26	5.04	25.4016
5	34.0	36.26	-2.26	5.1076
Total	181.3	36.26		59.7720

Table 8: Summary of Results

Mix	w/c ratio	Mean strength, $\bar{x}$ (N/mm ²)	Sample SD, s (N/mm ²)	Characteristic strength, fck (N/mm ²)
Mix 1	0.580	37.88	2.747	33.37
Mix 2	0.587	38.52	2.762	33.99
Mix 3	0.594	36.26	3.866	29.92

4 DISCUSSION

The results demonstrate differences in the compressive-strength performance of the three mix proportions. Mix 1 produced a mean strength of 37.88 N/mm² and a calculated characteristic strength of 33.37 N/mm². Mix 2 produced the highest mean strength, 38.52 N/mm², and the highest calculated characteristic strength, 33.99 N/mm². Mix 3 produced a lower mean strength of 36.26 N/mm² and the largest sample standard deviation, 3.866 N/mm².

The recalculation is important because the original manuscript reported a standard deviation of 3.563 N/mm² for Mix 3. Based on the five reported strengths (38.9, 31.6, 35.5, 41.3 and 34.0 N/mm²), the sum of squared deviations is 59.772 and the sample standard deviation is 3.866 N/mm². Consequently, the characteristic strength calculated using $f_{ck} = \bar{x} - 1.64s$ is 29.92 N/mm² rather than 30.417 N/mm².

Mix 2 therefore provides the strongest performance among the three mixes and exceeds the 30 N/mm² target. Mix 1 also exceeds the target and uses the lowest cement content of the three mixes. Although this makes Mix 1 potentially attractive from a material-consumption perspective, the study does not contain a formal cost analysis; consequently, it is more appropriate to describe Mix 1 as a lower-cement-content alternative rather than definitively as the most economical mix.

The findings should be interpreted within the limitations of the experimental programme. Only five specimens were tested per mix and only 28-day compressive strength was assessed. Properties relevant to paving units, including splitting tensile strength, abrasion resistance, water absorption and weathering durability, were not investigated in the reported work. Concrete paving blocks are commonly evaluated using multiple performance properties, not compressive strength alone. [\[cite?turn0search12?turn0search13\]](#)

5 CONCLUSION

Three concrete mix proportions were investigated for the production of interlocking concrete tiles with a target characteristic strength of 30 N/mm². Mix 2 achieved the highest mean compressive strength (38.52 N/mm²) and calculated characteristic strength (33.99 N/mm²). Mix 1 achieved a mean strength of 37.88 N/mm² and calculated characteristic strength of 33.37 N/mm² while using the lowest cement content. Mix 3 achieved a mean strength of 36.26 N/mm², but its recalculated characteristic strength was 29.92 N/mm² and therefore marginally below the target.

On the basis of compressive strength, Mix 2 is the preferred mix among those investigated. Mix 1 is a potentially useful lower-cement-content alternative because its calculated characteristic strength exceeds the target. Further work should include a larger number of specimens, formal cost analysis and durability-related tests appropriate to concrete paving units before field-scale adoption.

LIMITATIONS OF THE STUDY

The study was limited to five specimens per mix and 28-day compressive-strength testing. The available experimental record did not provide detailed information on aggregate grading curves, cement type and grade, batching tolerance, specimen dimensions, testing-machine verification, loading rate or the complete SCALE 149 design output. These details should be incorporated from the laboratory and mix-design records before final publication if available.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

I declared that there is no conflict of interests exist.

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