

Waste Materials in Concrete
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Introduction

Concrete is the most commonly used construction material in the world, being one of the most flexible, robust and cost-effective building materials in use today. Cement production accounts for the highest cost in the manufacture of concrete.

This work has been focused on the necessity of using partial cement substitute materials to minimise the use of sand and cement inside concrete, the two existing substitutes are ground blast furnace slag and limestone dust.

This paper addresses principles upon which to maximise the use of the waste materials in concrete, there is also talk about concrete properties such as flexibility and compression and can it be engineered better by using these waste materials.

Aim

This dissertation will examine how two types of waste material can benefit the construction industry by reducing the amount of cement and sand in concrete and adding these materials, the materials being used are already established and approved in the industry and what the waste materials physical and chemical elements contain for it be suitable for a cement and sand reduction. these waste materials that are going to be used are slag and limestone dust, as the slag will reduce the cement and the limestone dust will reduce the sand.

Experiment

To achieve the reduction of cement and sand in concrete the author conducted experiments that looked for the properties such as workability, flexural strength and compression. Each test was done more than once so that an average can be calculated and multiple experiments with different percentages of cement and sand with a mixture of slag and limestone dust has been achieved.

Flexural Test

Flexural measurements are typically used to determine the flexural modulus or flexural strength of an object. A flexure test is more cost effective than a tensile test, with very different test outcomes.

The material is laid horizontally over two contact points (lower support span) and then a force is applied to the top of the material, either through one or two contact points (upper load span) before the sample fails. The maximum force registered for this particular sample is the flexural power.



Table to show the first 9 concrete batches flexural and compression in 7 and 28 days

Batch's	Flexural Testing after 7 days (KN)	Compressive Strength test after 7 days (KN)		Flexural Testing after 28 days (1) (KN)	Compressive Strength test after 28 days (1) (KN)		Flexural Testing after 28 days (2) (KN)	Compressive Strength test after 28 days (2) (KN)	
1	2.887	44.308	45.068	4.370	65.166	65.542	3.889	64.124	64.475
2	3.073	27.984	28.670	4.241	37.052	44.348	4.280	45.175	42.041
3	4.299	42.278	50.664	5.782	80.548	82.052	4.899	75.977	78.243
4	2.893	33.750	30.375	3.549	38.951	39.643	3.735	57.873	55.601
5	4.630	58.594	47.110	4.788	58.646	65.321	5.105	65.321	63.249
6	4.436	55.099	46.533	5.560	58.372	57.779	4.857	66.031	66.281
7	1.195	12.457	11.165	1.919	20.073	27.345	0.793	24.730	25.207
8	1.482	13.476	14.190	2.825	28.221	30.325	2.378	27.119	30.440
9	1.918	18.500	19.479	3.553	39.502	23.087	3.564	29.901	30.415

Table to show the second batch of 9 concrete batches flexural and compression in 7 and 28 days

Batch's	Flexural Testing after 7 days (KN)	Compressive Strength test after 7 days (KN)		Flexural Testing after 28 days (1) (KN)	Compressive Strength test after 28 days (1) (KN)		Flexural Testing after 28 days (2) (KN)	Compressive Strength test after 28 days (2) (KN)	
1	3.002	38.461	36.536	1.414	60.061	57.161	3.844	46.982	49.178
2	2.530	36.337	39.426	2.628	34.619	38.724	4.408	45.532	42.617
3	4.713	44.262	44.733	4.493	63.123	62.725	5.432	59.641	60.752
4	2.357	28.980	29.843	3.374	50.090	51.142	3.655	47.348	49.794
5	2.775	27.910	29.491	3.294	54.383	52.888	3.645	51.068	52.335
6	4.210	33.960	31.575	4.968	76.188	63.765	5.455	76.598	69.451
7	0.995	8.301	9.908	2.809	23.581	23.952	2.302	25.132	22.754
8	1.213	11.007	11.958	2.728	27.150	27.521	2.477	17.902	17.404
9	1.530	15.040	16.129	3.241	34.358	33.913	3.306	35.249	35.057

Conclusion of Results

- ⌚ Replacing sand with lime stone increases the flexural and compressive strength to a standard concrete mix
- ⌚ Replacing cement by 50% with blast furnace slag decreased the flexural and compressive strength overall to a standard concrete mix
- ⌚ Reducing the sand by 25% with lime stone does increase flexural and compressive strength but not by a larger margin than replacing sand completely
- ⌚ Reducing sand and cement with lime stone by 25% and blast furnace slag by 30% does increase the flexural and compressive strength in comparison to a normal concrete mix