The Application Research on Waste Clay Brick in the Cement Concrete

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Abstract. The construction waste has been produced more and more with the rapid development of urbanization and industrialization in China in recent years. The waste clay brick of construction waste named recycled coarse aggregate was mixed with cement concrete mainly by making laboratory experimental study. The clay brick as recycled coarse aggregate was mixed into the concrete at 0%, 20%, 25%, 30%, 35%, 40%, 50%, 60%, 70%, 80%, 100% and fixed water-cement ratio according to references at home and abroad, which made the C30 standard test blocks, and strictly controlled the variable of the coarse aggregate replacement rate; the slump and 7-day compressive strength were measured, and their performance was compared with that of the standard C30 concrete specimen; the optimum range of incorporation of recycled aggregate would be put forward according to their performance. This result would have a certain significance in waste bricks.

1 Introduction

The demand for construction resources has been rapidly growing with the rapid development of urbanization and industrialization in China in recent years, along with more and more construction waste generated. The current construction waste production has reached about 800 million and 0.6 tons per capita; the amount of waste generated in the construction of the future are predicted that the future construction waste production will reach 10 million tons in 10 years [1]-[5]. The number of construction waste generated in urban construction has accounted for 30% -40% of the total municipal solid waste according to the survey; the vast part of the construction waste is being transported directly into the wild pile or landfill, which will occupy a lot of land, and even the occupation of arable land and farmland. Construction waste will be nowhere in a certain time if they are dealt with in this way a long-term [1]-[5]. While construction debris during transportation will produce dust, gray sand flying and other issues, bring about a lot of pollution to the environment, and lead to people's lives inconvenience. They will also have a small fortune in fees during transportation. It is said that these waste is such as resources that were just put in the wrong place. A lot of research institutions have been conducting research in foreign countries, and made great achievements. Construction waste utilization it is not very common in the domestic, so people can fully draw on advanced foreign technology and processing methods to use construction waste combined with China's actual situation. The foregoing analysis shows that the construction waste recycled has become an urgent problem.

The waste clay brick would be used to replace part of the coarse aggregate in the concrete as recycled coarse aggregate. The technical indicators would be made by crushing test, and to mix design a concrete thickness C30 according to the aggregate value; the recycled coarse aggregate were incorporated into the concrete at 0%, 20%, 25%, 30%, 35%, 40%, 50%, 60%, 70%, 80%, 100% by a fixed water-cement ratio method, formulating a standard block to measure the compressive strength; the best incorporation of recycled aggregate value range would be obtained.

2 Raw materials and technical indicators

The raw materials contain natural pebbles in Yuzhong County, river sand clay brick construction waste, and naphthalene superplasticizer, P.O 42.5, etc. Their technical indicators were shown in Table 1.

2.1 The main formulas [6]

a. The bulk density of natural coarse aggregate and fine aggregate:

\[ \rho'_0 = (m_2 - m_1) / v_0' \times 1000 \]  

where: \( m_1 \) — Capacity cartridge mass, kg; \( m_2 \) — Capacity cartridge and gravel mass, kg

\( v_0' \) — Capacity cartridge volume, L

b. The crushing index of natural coarse aggregate:

\[ \text{Crushing index} = (G_0 - G_1) / G_0 \times 100\% \]  

where: \( G_0 \) — Sample mass, kg; \( G_1 \) — Sieve allowance, kg
2.2 General technical indexes

The cementitious material is P.O 42.5, and its technical indexes are seen in Table 1. The naphthalene superplasticizer as water reducing agent was used in this experiment, which the water reduction rate of 20% was measured; the appearance took on yellow powder; the solid content was greater than 92%; PH value (5% aqueous solution)was 7-9; sodium content was 16-19%; cement paste fluidity was not less than 200mm; the concrete strength increases by 15-40% at early and night strength for the significant concrete to enhance the effect; it fully improves and enhances the physical and mechanical properties of concrete, and save 10-20% of cement maintaining the strength of the same; it has no corrosion of steel effect.

The recycled aggregate [7], [8] is mainly clay brick used in building demolition wall materials. The collected clay bricks were crushed with jaw crusher; then they were used the standard sieving to sieve and done an adjustments in accordance with the norms [9]. The aggregate Technical indicators were shown in Table 2.
Table 3. The amount of material (kg/m³).

| Num. | CA replacement rate (%) | W/C | Superplasticizer(g) | Pebble | RA | S | W | C |
|------|-------------------------|-----|--------------------|--------|----|---|---|---|
| 1    | 0                       | 0.45| 20                 | 1250.02| 100| 673.09| 148| 328.89|
| 2    | 20                      | 0.45| 20                 | 1250.02| 80 | 673.09| 148| 328.89|
| 3    | 25                      | 0.45| 20                 | 1250.02| 75 | 673.09| 148| 328.89|
| 4    | 30                      | 0.45| 20                 | 1250.02| 70 | 673.09| 148| 328.89|
| 5    | 35                      | 0.45| 20                 | 1250.02| 65 | 673.09| 148| 328.89|
| 6    | 40                      | 0.45| 20                 | 1250.02| 60 | 673.09| 148| 328.89|
| 7    | 50                      | 0.45| 20                 | 1250.02| 50 | 673.09| 148| 328.89|
| 8    | 60                      | 0.45| 20                 | 1250.02| 40 | 673.09| 148| 328.89|
| 9    | 70                      | 0.45| 20                 | 1250.02| 30 | 673.09| 148| 328.89|
| 10   | 80                      | 0.45| 20                 | 1250.02| 20 | 673.09| 148| 328.89|
| 11   | 100                     | 0.45| 20                 | 1250.02| 0  | 673.09| 148| 328.89|

Table 4. Indexes value of concrete.

| Test block Numbering | Stress (kN) | Compressive strength (MPa) | Slump (mm) | Mass (kg) |
|----------------------|-------------|-----------------------------|------------|-----------|
| 1                    | 516.033     | 22.933                      | 72         | 8.086     |
| 2                    | 639.667     | 28.430                      | 79         | 7.835     |
| 3                    | 788.757     | 35.056                      | 70         | 7.920     |
| 4                    | 648.000     | 28.8                        | 75         | 7.865     |
| 5                    | 559.800     | 24.880                      | 70         | 7.650     |
| 6                    | 521.100     | 23.16                       | 73         | 7.486     |
| 7                    | 502.425     | 22.33                       | 75         | 7.257     |
| 8                    | 498.375     | 22.15                       | 72         | 7.089     |
| 9                    | 481.95      | 21.42                       | 74         | 6.881     |
| 10                   | 446.625     | 19.85                       | 75         | 6.792     |
| 11                   | 428.02      | 19.023                      | 75         | 6.770     |

5 Conclusions

The admixing amount of recycled aggregate as a variable was strictly controlled in the testing process; the strength of the test pieces with recycled aggregate first increased and then decreased. Eventually the recycled aggregate range could be drawn upon incorporation of 20% to 35%; this range could make concrete strength greatly improved. The results showed that the waste clay bricks can not only save resources, but also protect the environment, which will bring great social benefits.

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