Data Article

Dataset on predictive compressive strength model for self-compacting concrete

O.M. Ofuyatan a, S.O. Edeki b

a Department of Civil Engineering, Covenant University, Ota, Nigeria
b Department of Mathematics, Covenant University, Ota, Nigeria

ARTICLE INFO

Article history:
Received 21 December 2017
Received in revised form 19 January 2018
Accepted 5 February 2018
Available online 9 February 2018

Keywords:
Predictive model
Compressive strength
Water cement ratio
Day-length

ABSTRACT

The determination of compressive strength is affected by many variables such as the water cement (WC) ratio, the superplasticizer (SP), the aggregate combination, and the binder combination. In this dataset article, 7, 28, and 90-day compressive strength models are derived using statistical analysis. The response surface methodology is used to investigate the effect of the parameters: Varying percentages of ash, cement, WC, and SP on hardened properties—compressive strength at 7, 28, and 90 days. The levels of independent parameters are determined based on preliminary experiments. The experimental values for compressive strength at 7, 28, and 90 days and modulus of elasticity under different treatment conditions are also discussed and presented. These dataset can effectively be used for modelling and prediction in concrete production settings.

© 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Specifications Table

Subject area Civil Engineering
More specific subject area Production of concrete and strength properties
Type of data Table, graph.
How data was acquired Laboratory experiment via response surface methodology
Data format Raw and Analyzed
Experimental factors Modelling and concrete strength

E-mail addresses: olatokunbo.ofuyatan@covenantuniversity.edu.ng (O.M. Ofuyatan), soedeki@yahoo.com (S.O. Edeki).

https://doi.org/10.1016/j.dib.2018.02.008
2352-3409/© 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
Experimental features
Compressive strength and self-compacting concrete
Data source location
Experimental and laboratory, Nigeria
Data accessibility
Within this article.

Value of the data

- The present data can be used to predict the strength of auto-compacting concrete at varying days.
- The dataset can be used to determine the trend of strength associate with concrete.
- The dataset can be used to detect the effect of SP.
- The dataset can be used to determine the nature of concrete, and the corresponding degree of hydration.
- The dataset can serve as an experimental framework for the analysis of other basic properties of concrete.
- The dataset can help in developing experimental programme for the evaluation of model accuracy and precision.

1. Data, and experimental design

Strength data presented here are from seventy-two (72) different POFA concrete samples fabricated to compare with normal concrete without ash. We make reference to [1–8] for related views such as forecasting and prediction. In this dataset article, a 7-day, 28-day, and 90-day compressive strength models were derived by statistical analysis and the proposed models results and description as contained in Tables 1–3, and Figs. 1–5 are as follows.

1.1. Sample preparation methods

In this investigation, concrete samples were prepared using Palm Oil Fuel Ash (POFA) at varying percentages, with ordinary Portland cement. The POFA was replaced at 5%, 10%, 15%, 20%, 25%, and 30% with cement and superplasticizer at 2%.

2. Materials and methods

2.1. Quadratic equation generated from the model

Besides the statistical software used in the data analysis, is a predictive quadratic model defined as follows:

$$f(x) = C_0 + \frac{C_1(x-x_0)}{1!(5^1)} + \frac{C_2(x-x_0)(x-x_1)}{2!(5^2)} + \frac{C_3(x-x_0)(x-x_1)(x-x_2)}{3!(5^3)} + \frac{C_4(x-x_0)(x-x_1)(x-x_2)(x-x_3)}{4!(5^4)} + \frac{C_5(x-x_0)(x-x_1)(x-x_2)(x-x_3)(x-x_4)}{5!(5^5)} + \frac{C_6(x-x_0)(x-x_1)(x-x_2)(x-x_3)(x-x_4)(x-x_5)}{6!(5^6)}$$

where $x$ and $C_i, i \geq 0$ denote varying percentages of POFA and compressive strength respectively.

2.2. Data analysis

For $x$ the varying percentages of POFA with zero (0) as the control, and the average compressive strength, we present in Tables 1–6 the relationship between $x$ and $y$ at varying intervals in days.

It is noted from Tables 1–6 that there was an increase in strength as the percentage of POFA increased but the control was slightly high. Table 7 shows the experimental and numerical results for POFA with regards to Compressive Strength for 7, 28, and 90 days.
Table 1
3 days experiment.

| x   | y    |
|-----|------|
| 0   | 30.94|
| 5   | 12.34|
| 10  | 14.24|
| 15  | 17.52|
| 20  | 23.63|
| 25  | 26.08|
| 30  | 30.68|

Table 2
7 days experiment.

| x   | y    |
|-----|------|
| 0   | 40.60|
| 5   | 12.77|
| 10  | 15.35|
| 15  | 18.67|
| 20  | 30.32|
| 25  | 31.80|
| 30  | 35.78|

Table 3
ppp 14 days experiment.

| x   | y    |
|-----|------|
| 0   | 52.10|
| 5   | 14.45|
| 10  | 17.24|
| 15  | 20.40|
| 20  | 34.71|
| 25  | 36.82|
| 30  | 46.30|

Fig. 1. Prediction and experimental result (3-days model).

Fig. 2. Prediction and experimental result (7-days model).
Fig. 3. Prediction and experimental result (14-days model).

Fig. 4. Prediction and experimental result (28-days model).

Fig. 5. Prediction and experimental result (56-days model).
The plots of the experimental values of the compressive strength at varying days vs the predicted strength using Matlab are shown via Fig. 1 through Fig. 5. The compressive strength values of POFA concrete were very close to the strength of normal concrete: 75.60 N/mm², 80.5 N/mm² respectively at 90 days.

2.3. Models correlation – predicted and measured

Matlab statistical software was used to analyse and investigate the effect of the parameters (cement, water cement (WC) ratio, POFA and superplasticiser (SP) on the hardened properties (compressive strength at 7, 28 and 90 days. Determination of the independent parameters with respect to their percentage replacement was made on initial experiments as shown in Tables 1–6, which also contains the experimental values of the increase in strength at 7, 28 and 90 days. The quadratic model equation was used to determine the experimental values and compared with the model. The predictive and experimental models showed the same values and pattern graphically as depicted in Figs. 1–5.

Table 4
28 days experiment.

| x    | 0  | 5  | 10 | 15 | 20 | 25 | 30 |
|------|----|----|----|----|----|----|----|
| y    | 40.60 | 15.72 | 17.85 | 22.63 | 38.35 | 48.70 | 55.74 |

Table 5
56 days experiment.

| x    | 0  | 5  | 10 | 15 | 20 | 25 | 30 |
|------|----|----|----|----|----|----|----|
| y    | 66.80 | 16.35 | 20.36 | 24.56 | 43.80 | 53.79 | 61.32 |

Table 6
90 days experiment.

| x    | 0  | 5  | 10 | 15 | 20 | 25 | 30 |
|------|----|----|----|----|----|----|----|
| y    | 80.50 | 17.28 | 21.40 | 26.77 | 57.09 | 59.54 | 75.60 |

Table 7
The experimental and numerical results.

| POFA (%) | 7 days | 28 days | 90 days |
|----------|--------|---------|---------|
|          | Compressive Strength (N/mm²) | Compressive Strength (N/mm²) | Compressive Strength (N/mm²) |
|          | Experimental | Numerical | Experimental | Numerical | Experimental | Numerical |
| 0        | 40.6 | 40.6 | 59.6 | 59.6 | 80.5 | 80.5 |
| 5        | 12.77 | 12.77 | 15.28 | 15.28 | 17.28 | 17.28 |
| 10       | 15.35 | 15.35 | 19.41 | 19.41 | 21.40 | 21.40 |
| 15       | 18.67 | 18.67 | 22.47 | 22.47 | 26.77 | 26.77 |
| 20       | 30.32 | 30.32 | 38.10 | 38.10 | 57.09 | 57.09 |
| 25       | 31.8 | 31.8000000305 | 41.5 | 41.5100000125 | 59.54 | 59.54000001 |
| 30       | 35.78 | 35.48001000125 | 53.48 | 53.48001000125 | 75.60 | 75.6000000625 |

The plots of the experimental values of the compressive strength at varying days vs the predicted strength using Matlab are shown via Fig. 1 through Fig. 5. The compressive strength values of POFA concrete were very close to the strength of normal concrete: 75.60 N/mm², 80.5 N/mm² respectively at 90 days.
Acknowledgements

The authors are grateful to Covenant University for the provision of resources, and enabling working environment.

Transparency document. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2018.02.008.

References

[1] S.E. Chidiac, F. Moutassem, F. Mahmoodzadeh, Compressive strength model for concrete, Mag. Concr. Res. 65 (9) (2013) 557–572.
[2] S.C. Paul, G.P.A.G. van Zijl, Mechanical and durability properties of recycled concrete aggregate for normal strength structural concrete, Int. J. Sustain. Constr. Eng. Technol. 4 (1) (2013) 89–103.
[3] I.H. Adebakin, J.T. Adu, O.M. Ofuyatan, Properties of concrete made with recycled coarse aggregates from old concrete cubes, in: Proceedings of the 8th International Structural Engineering and Construction Conference: Implementing Innovative Ideas in Structural Engineering and Project Management (ISEC 2015), 2015, pp. 607–612.
[4] O.E. Babalola, P.O. Awoyeru, Suitability of Cordamillenii ash blended cement in concrete production, Int. J. Eng. Res. Afr. 22 (2016) 59–67 (ISSN 1663-4144).
[5] N.A. Sulymon et al., Engineering properties of concrete made from gravels obtained in Southwestern Nigeria, Cogent Engineering, 4, 1, 1295, 793.
[6] S.C. Paul, Data on optimum recycle aggregate content in production of new structural concrete, Data Brief. 15 (2017) 987–992.
[7] A.A. Adebiyi, C.K. Ayo, S.O. Otokiti, Stock price prediction using hybridized market indicators, in: International Conference on Artificial Intelligence and Pattern Recognition AIPR, 2009, pp. 372–379.
[8] O.M. Ofuyatan, et al., Structural characteristics of high strength palm oil fuel ash self compacting concrete, Int. J. Sci. Eng. Res. 5 (3) (2014) (ISSN 2229-5518).