JUNE 27–29, 2022
ISEP · PORTO, PORTUGAL

INTERNATIONAL CONFERENCE Mathematical Analysis and Applications in Science and Engineering

Book of Extended Abstracts

isep Instituto Superior de Engenharia do Porto · P.PORTO · U.PORTO
UNIVERSIDAD COMPLUTENSE MADRID · 1 DECEMBRIE 1918 UNIVERSITY OF ALBA IULIA · جامعة 8 ماي 1945 قالمة · espol Escuela Superior Politécnica del Litoral

INTERNATIONAL CONFERENCE on Mathematical Analysis and Applications in Science and Engineering ICMA^{2}SC'22

BOOK OF EXTENDED ABSTRACTS

Bibliographic Information

Book Title

International Conference on Mathematical Analysis and Applications in Science and Engineering – Book of Extended Abstracts

Series Editors

Carla M.A. Pinto, School of Engineering, Polytechnic of Porto and Centre for Mathematics, University of Porto

Jorge Mendonça, School of Engineering, Polytechnic of Porto

Lurdes Babo, Porto Accounting and Business School

Dumitru Baleanu, Cankaya University

Publication Year: 2022

Publisher

ISEP | P.PORTO

Book ISBN & DOI

978-989-53496-3-0

https://doi.org/10.34630/20734

Conference Name

ICMA²SC'2022

Dates & Location

June 27th-29th 2022, School of Engineering, Polytechnic of Porto, Porto, Portugal

Information about the Editors

Dr. Carla M.A. Pinto is a Coordinating Professor in the School of Engineering, Polytechnic of Porto, Portugal. Her main research topic is epidemiology, in particular Mathematical Epidemiology. She is interested in mathematical challenges and their role in providing advice on public health policies. Mrs Pinto is trained in Nonlinear Dynamics, Bifurcation Theory. Previous research included the analysis of Central Pattern Generators for Animal and Robot Locomotion, coupled cell networks, neuron-like equations (Hodgkin-Huxley equations, Fitz-Hugh Nagumo, Morris-Lecar).

Dr. Jorge Mendonça is Adjunct Professor in the School of Engineering, Polytechnic of Porto, Portugal. He holds a PhD degree in Statistics and Operational Research from the University of Vigo, a Master's degree in Statistics and Probability from the Faculty of Sciences of the University of Lisbon. Survival analysis is his main interest particularly applications of the missing censoring indicator model. Other interests are innovative methodologies in Engineering education, interactive learning and survey analysis.

Dr. Lurdes Babo is senior lecturer at ISCAP, the Porto Accounting and Business School from the Polytechnic of Porto, Portugal, and researcher at CEOS.PP. She has experience in lecturing mathematics and statistics. She holds a PhD in Applied Mathematics, University of Porto, Portugal. Her research interests include ICT, Finance, Time Series Analysis, Simulation and QMC methods.

Professor Dumitru Baleanu is a Professor at the Institute of Space Sciences, Magurele-Bucharest, Romania and a visiting staff member at the Department of Mathematics,Cankaya University, Ankara, Turkey. Dumitru Baleanu got his PhD from the Institute of Atomic Physics in 1996. His fields of interest include the fractional dynamics and its applications, fractional differential equations and their applications, discrete mathematics, image processing, bio-informatics, mathematical biology, mathematical physics, soliton theory, Lie symmetry, dynamic systems on time scales, computational complexity, the wavelet method and its applications, quantization of systems with constraints, the Hamilton-Jacobi formalism, geometries admitting generic and non-generic symmetries. Dumitru Baleanu is one of the pioneers of the fractional variational principles and their applications in control theory.

Dedication

In memoriam of Professor J.A. Tenreiro Machado (1957 - 2021), an enthusiastic scientist, respected colleague, generous person, and trustworthy friend. More information here.

Professor J.A. Tenreiro Machado (1957 - 2021)

International Conference on Mathematical Analysis and Applications in Science and Engineering
ICMA²SC'22
ISEP Porto-Portugal, June 27 - 29, 2022

Response models in experimental studies of fresh properties of cement pastes: Part I – typical approach through changes one-variable-at-a-time

Lino Maia[1,2*]

[1] CONSTRUCT-LABEST, Faculty of Engineering (FEUP), University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal.

[2] Faculty of Exact Sciences and Engineering, University of Madeira, Campus da Penteada, 9020-105 Funchal, Portugal.

[1*]linomaia@fe.up.pt

Abstract: The experimental plan affects the fresh properties cement-based materials. This document regards to Part I of a major work wherein workability of cement-based pastes is evaluated. Here, several cement-based paste compositions incorporating distinct constituent materials were tested and their effect on the measured. The overall work is composed by two parts. Here, in Part I, basic and typical run of experiments wherein only one input parameter is studied at once were applied. The results of Part I shown that basic run of experiments is easy and quick of develop and leads to results of easy analyses, however advanced and scientific analyses are difficult.

keywords: Approach; Cement paste; Response Models; Trial-error.

MSC2020: 49-XX; 34-XX; 92-XX.

1 Introduction

The road to produce concrete can be understood as very easy as well as demanding high-tech and scientific knowledge. On the one hand, it is just mixing gravel, sand, cement, water and eventually admixtures and additions in a trial-error method and 'a concrete' is produced. However, on the other hand when specific and unusual properties are required and no fail is accepted, high-tech and scientific kwon-how is crucial to achieve and define responsibilities.
As a part of a major research work on the fresh properties of cement-based pastes wherein different experimental approaches were used, the present paper reports the findings of the Part I of the research wherein the experimental program was carried out performing changes in the input variables within the traditional approach 'one-variable-at-a-time'. Other results of the overall research work can be found in the Part II wherein the experimental program was carried out through a statistical approach, i.e. applying a central composite design of experiments. Thus, the major goals of this paper (Part I) are (i) to characterize the primary effects of the different constituent materials of cement pastes on the fresh properties and parallelly (ii) to analyze and ponder about the type of research methodology applied, namely advantages and disadvantages of the traditional approach of changing one-variable-at-a-time when compared to an experimental program planed based on a central composite design. Therefore, in this paper 92 mix compositions are done while in the Part II only 15 mix compositions were executed. The overall research was carried out in cement-based pastes with the mini-cone [1] and the Marsh funnel [2] tests being performed to evaluate fresh properties. Being aware that results from Part I and Part II do not compare between themselves, rather they complement the overall characterization, the used approaches are evaluated and compared.

2 Results and discussion

In this experimental program it was also evaluated the loss of workability with the time. Two superplasticizers were tested in order to detect differences. Figure 1 shows graphically the loss of deformability of the two superplasticizer from immediately after mixing to 60 minutes after starting mixing. Similarly, Figure 2 shows the increase of viscosity.

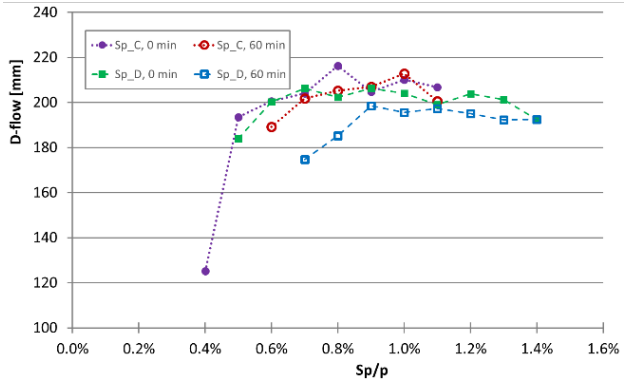

Figure 1 – Effect of two superplasticizers on the flow ability of mixes immediately after mixing and 60 minutes after start mixing

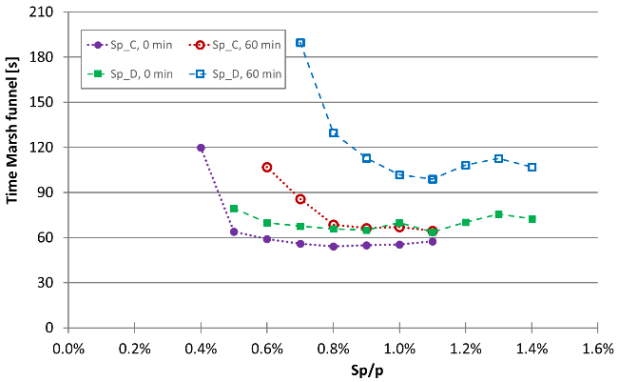

Figure 2 – Effect of two superplasticizers on the viscosity immediately after mixing and 60 minutes after start mixing evaluated through time of the Marsh funnel

Results of the flow ability immediately after mixing of mixes composition are reported Table 1 as well as the corresponding coefficients of the linear regressions and the R^2.

Table 1 – Linear regressions of the flow ability of mixes with different limestone filler content and different types of cement.

#	Mix	D1a	D1b	D2a	D2b	D-flow	Linear regression
1	100%C,0%F-1	90	90	91	91	90.5	
2	100%C,0%F-2	95	95	100	101	97.8	
3	100%C,0%F-3	109	110	112	114	111.3	a= 0.006961
4	100%C,0%F-4	123	123	129	130	126.3	b= 0.770234
5	100%C,0%F-5	139	139	140	141	139.8	R2= 0.978597
6	100%C,0%F-6	143	143	145	146	144.3	
7	100%C,0%F-7	151	151	153	153	152.0	
8	70%C,30%F-1	93	94	99	99	96.3	
9	70%C,30%F-2	105	105	111	112	108.3	
10	70%C,30%F-3	119	119	129	129	124.0	a= 0.008278
11	70%C,30%F-4	125	126	130	131	128.0	b= 0.510641
12	70%C,30%F-5	135	135	135	135	135.0	R2= 0.967530
13	70%C,30%F-6	144	142	147	147	145.0	
14	70%C,30%F-7	152	152	146	146	149.0	
15	85%C,15%F-1	92	93	93	93	92.8	
16	85%C,15%F-2	102	102	105	105	103.5	
17	85%C,15%F-3	119	119	116	116	117.5	a= 0.007501
18	85%C,15%F-4	129	129	123	123	126.0	b= 0.660015
19	85%C,15%F-5	141	141	141	141	141.0	R2= 0.953415
20	85%C,15%F-6	127	128	145	145	136.3	
21	85%C,15%F-7	155	155	150	151	152.8	
22	55%C,45%F-1	78	79	77	78	78.0	
23	55%C,45%F-2	89	89	88	87	88.3	
24	55%C,45%F-3	94	94	98	98	96.0	
25	55%C,45%F-4	120	121	115	114	117.5	a= 0.006733
26	55%C,45%F-5	133	132	116	116	124.3	b= 0.636062
27	55%C,45%F-6	123	123	132	132	127.5	R2= 0.980954
28	55%C,45%F-7	144	144	150	151	147.3	
29	55%C,45%F-8	144	145	162	162	153.3	
30	55%C,45%F-9	155	150	166	168	159.8	
31	0%C,100%F-1	105	106	105	105	105.3	
32	0%C,100%F-2	115	115	123	125	119.5	
33	0%C,100%F-3	125	125	133	134	129.3	a= 0.007514
34	0%C,100%F-4	145	145	145	146	145.3	b= 0.329800
35	0%C,100%F-5	141	142	148	149	145.0	R2= 0.919727
36	0%C,100%F-6	144	144	148	148	146.0	
37	0%C,100%F-7	154	155	165	165	159.8	
38	100%C+, 0%F-1	93	92	-	-	92.5	
39	100%C+, 0%F-2	102	102	-	-	102.0	a= 0.008734
40	100%C+, 0%F-3	114	113	-	-	113.5	b= 0.954350
41	100%C+, 0%F-4	141	139	-	-	140.0	R2= 0.963781
42	100%C+, 0%F-5	158	160	-	-	159.0	
43	80%C, 20%C+, 0%F-1	97	98	-	-	97.5	
44	80%C, 20%C+, 0%F-2	114	114	-	-	114.0	a= 0.008849
45	80%C, 20%C+, 0%F-3	133	135	-	-	134.0	b= 0.683382
46	80%C, 20%C+, 0%F-4	156	156	-	-	156.0	R2= 0.977411
47	80%C, 20%C+, 0%F-5	161	163	-	-	162.0	

3 Conclusions and Future work

In this paper the typical approach wherein the input parameters were changed within the approach one-variable-at-a-time to characterize their effect on the fresh state of cement-based pastes – the results found are in agreement with the literature [4-9]. A vision of the advantages and disadvantages of the approach one-variable-at-a-time to apply response models when compared with the one applied in the Part II is portrayed below.

- Advantages

- Basic studies allow understanding the primary effects of the input parameter on the responses. It is easier to test different materials and check their main effects.
- Simple experimental plans: with a few mixtures some tends are recognized.
- Experimental plans may be adapted during the plan.
- Trail-error experiments may be enough to check some doubts.
- Appropriate to detect primary linear regressions.
- Advanced expertise in statistics is not mandatory.
- Interesting for rudimentary analysis.

- Disadvantages

- Studies are usually conducted under small and basic sets to be easier to interpretate and analyze and consequently do not allow applying advanced response models being typically reported through linear regressions with the R^2.
- Studies are not extensive, therefore data is not published because their scientific interpretation lacks support.
- When several parameters need to be studied, the experimental program increased drastically and the interpretation of results and the comparison between parameters are difficult.
- No advanced response models are obtained to identify secondary and cross effects.
- As the results lack of a scientific approach frequently they are not deeply studied – here, in this paper, that happened with the SRA study.

Acknowledgments

This work is financially supported by: Base Funding – UIDB/04708/2020 of the CONSTRUCT – Instituto de I&D em Estruturas e Construções - funded by national funds through the FCT/MCTES (PIDDAC). This work is funded by national funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., under the Scientific Employment Stimulus – Institutional Call – CEECINST/00049/2018.

References

[1] Kantro, D. L. Influence of water-reducing admixtures on properties of cement paste - a miniature slump test. Cem. Concr. Aggregates 2, 95–102 (1980).

[2] EN 445:2008 - Grout for prestressing tendons - Test methods.

[3] Nunes, S., Oliveira, P. M., Coutinho, J. S. & Figueiras, J. Interaction diagrams to assess SCC mortars for different cement types. Constr. Build. Mater. 23, 1401–1412 (2009).

[4] Yahia, A., Tanimura, M. & Shimoyama, Y. Rheological properties of highly flowable mortar containing limestone filler-effect of powder content and W/C ratio. Cem. Concr. Res. 35, 532–539 (2005).

[5] Petit, J. Y. & Wirquin, E. Effect of limestone filler content and superplasticizer dosage on rheological parameters of highly flowable mortar under light pressure conditions. Cem. Concr. Res. 40, 235–241 (2010).

[6] Juvas, K., Kappi, A., Salo, K. & Nordenswan, E. The Effects of Cement Variations on Concrete Workability. Nord. Concr. Res. 26, 39–46 (2001).