

A Comprehensive Method for Concrete Mix Design



Kambiz Janamian
Jose Aguiar

M|R|F

A Comprehensive Method for Concrete Mix Design

Author

Kambiz Janamian

Co-author

Jose Aguiar

I dedicate this to:

*my beloved wife Parinaz, the best participant in my life,
and my little son*

Copyright © 2020 by the author

Published by **Materials Research Forum LLC**
Millersville, PA 17551, USA

All rights reserved. No part of the contents of this book may be reproduced or transmitted in any form or by any means without the written permission of the publisher.

Published as part of the book series
Materials Research Foundations
Volume 65 (2020)
ISSN 2471-8890 (Print)
ISSN 2471-8904 (Online)

Print ISBN 978-1-64490-058-1
ePDF ISBN 978-1-64490-059-8

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Distributed worldwide by

Materials Research Forum LLC
105 Springdale Lane
Millersville, PA 17551
USA
<http://www.mrforum.com>

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

Table of Contents

1.	Introduction.....	5
2.	Concrete constituent materials specification	6
	2.1 Portland cement	6
	2.1.1 Cements for our mix design check.....	8
	2.2 Other binders (Supplementary cementitious materials).....	11
	2.2.1 Silica Fume	12
	2.2.2 Ground Granulated Blast Furnace Slag (GGBS)	13
	2.2.3 Fly Ash	13
	2.2.4 Natural Pozzolans	13
	2.2.5 Blended Cement	14
	2.3 Aggregates	15
	2.3.1 Coarse aggregates	15
	2.3.2 Choosing maximum size of coarse aggregate	16
	2.3.3 Fine aggregates	17
	2.3.4 Aggregates for our mix design check.....	17
	2.4 Water for concrete	20
	2.5 Chemical admixtures	21
	2.5.1 Air entraining admixtures.....	22
	2.5.2 Plasticizers and super-plasticizers	22
	2.5.3 The novel test for obtaining water reduction rate of any plasticizer or super-plasticizer using cement mortar	23
	2.5.4 Super-plasticizer for mix design check	24
	2.5.3 Control the water reduction rate for concrete.....	27
3.	Concrete properties	29
	3.1 Fresh concrete.....	29
	3.2 Control the temperature of fresh concrete.....	30
	3.2.1 Workability	31
	3.2.2 Entrapped air	32
	3.3 Hardened concrete	33
	3.3.1 Concrete compressive strength test	33
	3.3.2 Permeability of concrete.....	35
4.	The novel step by step procedure for the concrete mix design	36
	4.1 Goals of the concrete mix design	36
	4.2 Step (1): Specify standard deviation	36

4.2.1	First method for standard deviation: Calculation from previous information	36
4.2.2	Second method for standard deviation	37
4.3	Step (2): Specify mix design compressive strength	38
4.4	Step (3): Specify percentage of each aggregate in the concrete	38
4.5	Step (4): Specify fineness module of total aggregates	39
4.6	Step (5): Specify water to binder ratio	40
4.7	Step (6): Specify free water in concrete	42
4.7.1	Using plasticizers and super-plasticizers and their effect in free water	43
4.8	Step (7): Specify the amount of cement and other binders	44
4.9	Step (8): Specify the total volume of aggregates in concrete	45
4.10	Step (9): Calculating the weight of aggregates in saturated surface dry (SSD) condition	46
4.11	Step (10): Calculating the real weight of aggregates and water in concrete	46
4.12	Making trial mix and control the specification for fresh and hardened concrete.....	46
5.	Implementing mix design for a sample ready mixed plant	47
5.1	Specification of the ready mixed plant.....	48
5.2	Different kinds of concrete in the ready mixed plant.....	49
5.3	Calculations for concrete mix design	50
5.3.1	Step (1): Specify standard deviation	50
5.3.2	Step (2): Specify mix design compressive strength	51
5.3.3	Step (3): Specify percent of each aggregate in the concrete	52
5.3.4	Step (4): Specify fineness module of total aggregates	56
5.3.5	Step (5): Specify water to binder ratio	57
5.3.6	Step (6): Specify free water in concrete	59
5.3.6.1	Using of super-plasticizer	61
5.3.7	Step (7): Specify the amount of cement and other binders	62
5.3.8	Step (8): Specify the total volume of aggregates in concrete	72

5.3.9 Step (9): Calculating the weight of aggregates in saturated surface dry (SSD) condition	74
5.3.10 Step (10): Calculating the real weight of aggregates and water in the concrete	82
5.3.11 Final mix design sheets.....	90
6. Confirmation tests for mix designs	131
6.1 Laboratory tests for mix design control	131
6.1.1 Laboratory trials results.....	133
6.2 Plant tests for checking concrete mix design	146
6.2.1 Test results for plant.....	146
6.2.3 Batching plant testing analysis.....	159
Conclusion.....	166
Appendix (1):	171
Mini slump method.....	171
Preparation of the grout:	171
Testing procedure:	171
Appendix (2):	173
Marsh cone test.....	173
Test procedure	173
Appendix (3):	175
References	177
About the authors.....	179