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Model code

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*fib* Bulletin 95 is published as a technical report and is a collection of contributions to a workshop that was co-sponsored by the *fib* and the American Concrete Institute (ACI). The authors have presented their individual views. Although these contributions have not been discussed in any of the *fib*'s working bodies, the subject matter is highly topical and believed to be of general interest to members of the *fib*.

This bulletin is also published as an ACI special publication, ACI SP-343.

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ISSN 1562-3610

ISBN 978-2-88394-141-0

<https://doi.org/10.35789/fib.BULL.0095>

Layout by Corinne Bottollier Dépois (*fib*).

Printed by DCC Document Competence Center Siegmars Kästl e.K., Germany

# Acknowledgements

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9	Ferrara, L.; Asensio, E.C.; Lo Monte, F.; Snoeck, D.; De Belie, N.	<a href="https://doi.org/10.35789/fib.BULL.0095.Ch09">https://doi.org/10.35789/fib.BULL.0095.Ch09</a>
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36	Amin, A.; Gilbert, R.I.	<a href="https://doi.org/10.35789/fib.BULL.0095.Ch36">https://doi.org/10.35789/fib.BULL.0095.Ch36</a>
37	Berrocal, C.G.; Lundgren, K.; Löfgren, I.	<a href="https://doi.org/10.35789/fib.BULL.0095.Ch37">https://doi.org/10.35789/fib.BULL.0095.Ch37</a>
38	de la Fuente, A.; Cavalaro, S.H.; Bairán, J.M.	<a href="https://doi.org/10.35789/fib.BULL.0095.Ch38">https://doi.org/10.35789/fib.BULL.0095.Ch38</a>
39	Zanotti, C.; Randl, N.; Gar, P.S.; Far, B.K.; Steiner, M.	<a href="https://doi.org/10.35789/fib.BULL.0095.Ch39">https://doi.org/10.35789/fib.BULL.0095.Ch39</a>
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43	Plückelmann, S.; Breitenbücher, R.	<a href="https://doi.org/10.35789/fib.BULL.0095.Ch43">https://doi.org/10.35789/fib.BULL.0095.Ch43</a>
44	Fantilli, A.P.; Nishiwaki, T.; Lisi, V.; Longo, M.	<a href="https://doi.org/10.35789/fib.BULL.0095.Ch44">https://doi.org/10.35789/fib.BULL.0095.Ch44</a>
45	Look, K.; Mark, P.	<a href="https://doi.org/10.35789/fib.BULL.0095.Ch45">https://doi.org/10.35789/fib.BULL.0095.Ch45</a>
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