

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Historical development	1
1.1.1	Evolution of reliability concepts and theory in structural design	1
1.1.2	Introduction of reliability concepts in seismic design	4
1.2	On the definition of performance	5
1.3	Type and nature of models in performance-based engineering	7
1.3.1	Hazard models	8
1.3.2	Response models	9
1.3.3	Performance models	10
	References	11
<b>2</b>	<b>Probabilistic seismic assessment</b>	<b>13</b>
2.1	Introduction	13
2.2	Conditional probability approach (IM-based methods)	13
2.2.1	PEER formulation	15
2.2.1.1	Summary	15
2.2.1.2	Introduction	15
2.2.1.3	Formulation	17
2.2.1.4	Application of PEER formulation	24
2.2.1.5	Closure	34
2.2.2	SAC/FEMA formulation	35
2.2.2.1	Motivation for the SAC/FEMA method	36
2.2.2.2	The formal aspects of the SAC/FEMA method and its limitations	36
2.2.2.3	MAF format	39
2.2.2.4	DCFD methodology	41
2.2.2.5	Theoretical background on SAC/FEMA assumptions	43
2.2.2.6	Illustrative assessment example of the DCFD methodology	45
2.2.2.7	Illustrative assessment example of the MAF methodology	47
2.2.2.8	Future applications and concluding remarks	49
2.3	Unconditional probabilistic approach	49
2.3.1	Introduction	49
2.3.2	Simulation methods	50
2.3.2.1	Monte Carlo simulation methods	50
2.3.2.2	Application to the estimation of a structural MAF	51
2.3.2.3	Importance sampling with K-means clustering	52
2.3.3	Synthetic ground motion models	54
2.3.3.1	Seismologically-based models	54
2.3.3.2	Empirical models	57
2.3.4	Flow-chart of a seismic assessment by complete simulation	61
2.3.5	Example	63
2.3.5.1	Illustration of MCS, ISS and IS-K methods	63
2.3.5.2	Comparison with the IM-based approach	66
	References	70
<b>3</b>	<b>Probabilistic seismic design</b>	<b>73</b>
3.1	Introduction	73
3.2	Optimization-based methods	73
3.2.1	Terminology	74
3.2.2	Tools for solving optimization problems	75
3.2.3	A review of structural optimization studies	77
3.2.4	Illustrative example	79

3.3	Non-optimization-based methods	84
3.3.1	Introduction	84
3.3.2	Performance-based seismic design with analytical gradients	85
3.3.2.1	Gradients	85
3.3.2.2	Iterative search for a feasible solution	86
3.3.2.3	Design of reinforcement	87
3.3.3	Illustrative example	87
3.3.3.1	Design	87
3.3.3.2	Validation	89
	References	90
<b>4</b>	<b>Appendix</b>	<b>93</b>
4.1	Excerpts from MATLAB script for PEER PBEE calculations	93
4.2	Excerpts from MATLAB script for unconditional simulation calculations	100
4.3	Excerpts from MATLAB script for TS algorithm calculations	108