

# Contents

Preface	vii
Acknowledgements	ix
Notation	xi
Introduction	xvii
<b>1 The nature of explosions</b>	<b>1</b>
1.1 The development of low and high explosives	1
1.2 Nuclear explosions	6
1.3 The analysis of detonation and shock in free air	8
1.4 The decay of instantaneous overpressure in free air	18
1.5 References	25
<b>2 The detonation of explosive charges</b>	<b>27</b>
2.1 Ground burst explosions	27
2.2 Above-ground explosions	30
2.3 Below-ground explosions	34
2.4 Underwater explosions	45
2.5 Equivalent pressure factors	55
2.6 References	56
<b>3 Propellant, dust, gas and vapour</b>	<b>59</b>
3.1 Liquid propellant explosions	59
3.2 Dust explosions	60
3.3 Gas explosions	63
3.4 Vapour cloud explosions	66
3.5 Thermal flash	69
3.6 References	69
<b>4 Structural loading from distant explosions</b>	<b>71</b>
4.1 Uniformly distributed pressures	72
4.2 Loading/time relationships	74

4.3 Loads on underground structures	80
4.4 Loads on underwater structures	86
4.5 References	88
<b>5 Structural loading from local explosions</b>	<b>91</b>
5.1 Concentrated external explosive loads on surface structures	91
5.2 Ground shock from concentrated underground explosions	95
5.3 Concentrated external loads on underwater structures	100
5.4 Blast loads in tunnels and shafts	102
5.5 Loads from confined explosions in unvented and vented chambers	111
5.6 References	117
<b>6 Pressure measurement and blast simulation</b>	<b>119</b>
6.1 Experimental pressure measurement	119
6.2 Blast simulation	123
6.3 Simulation of loads on underground structures	134
6.4 References	138
<b>7 Penetration and fragmentation</b>	<b>141</b>
7.1 Introduction	141
7.2 Penetration into soil, stone and rock	143
7.3 Penetration into concrete	164
7.4 Projectile damage to metal structures	169
7.5 Fragmentation	174
7.6 Delivery systems and their development	176
7.7 References	179
<b>8 The effects of explosive loading</b>	<b>183</b>
8.1 Civil buildings	183
8.2 Civil bridges	191
8.3 Aircraft and ships	207
8.4 References	213
<b>9 Response, safety and evolution</b>	<b>215</b>
9.1 Introduction	215
9.2 Theoretical response	217
9.3 Load factors	223
9.4 Evolution	226
9.5 References	227
Author index	229
Subject index	235