CONTENTS

		Page
Chapter	1 Introduction	1
	Three Principles	2
	Some Definitions	4
	Materials	6
	Plan of the Monograph	9
	Packings	9
	Elementary statics	9
	Measurement of powder properties	10
	Flow patterns	10
	Kinematics	11
	Discussion	11
	Selection of References to Particle Size and Shape	12
Chapter	2 Packings	13
Chapter	Bulk Density	13
	Wall effect	15
	Closely graded spherical granules	16
	Closely graded iregular granules	17
	Binary granular mixes	18
	Mixtures	21
	Graded cohesive powders	21
	Coordination numbers	22
	Radial distributions	24
A ~ 1 ~ ~ ~ £		24 24
Angles of	1	
	Graded granular powders	27
	Conical heap α_3	28
	Two-dimensional slope α_3	29
	Crater angles α_e	30
	Instantaneous free surface α_I	30
	Cohesive powders	35
	Compaction and moisture content	37
	Discussion	38
Chapter	3 Elementary Statics	40
	Plane Stress Analysis	41
	The Mohr circle diagram	45
	The principal planes	47
	The equations of equilibrium	47
	Coulomb Powders	49
	The mobilization of friction	50
	The directions of sliding	51
	The principal stresses in plastic equilibrium	51
	Active and passive Rankine states	53
	The pressures on a smooth, vertical retaining wall	55
	Active and passive failure	57
	The Shape of a Self-supporting Dome over a Circular Aperture	57
	Arching in Shallow Beds	64
	Arching in Deep Beds	67
	Janssen's Equation for the Pressure in a Tall Bin	68
	Practical Observations	73
	Experimental evidence relating to Janssen's equation	73
	Pressures measured in hoppers	79
		, ,

	Discussion	80
Chapter	4 Measurement of Powder Properties	82
	Friction and Cohesion	82
	Tensile Strength	83
	Shear Strength	87
	Dilatancy	91
	Ready sliding The Shear cell	94 96
	Yield locus	96 97
	The Critical Voids Ratio	102
	Summary	102
	Wall Friction and Adhesion	111
	Discussion	114
Chapter	5 Flow Patterns and Segregation	116
	Introduction	116
	Flow Patterns	117
	Experimental methods	117
	Scaling of models	117
	Discharge of a powder from a cylindrical bin	119
	Discharge of a granular powder from a flat bin	120
	Surfaces of sliding Discharge of beads from a conical hopper	122 122
	Flow regulators	124
	Flow through chutes	124
	Discussion	128
	Segregation and Percolation	129
	Size segregation	129
	Density segregation	133
	Percolation	133
Chapter	6 Kinematics	135
	Introduction	135
	Dilatant waves	135
	Free-fall arch	139
	Stream tubes Radial flow	141 143
	Angles of approach	150
	Discussion	157
	Energy Dissipation Postulate	157
	Minimum energy theorem	158
	The statistically empty space	160
	Mass flow rate in a symmetrical wedge	160
	Mass flow rate in an asymmetrical wedge	164
	Mass flow rate in a cone	165
	Mass Flow Rates	167
	Some general observations	167
	Experimental method	170
	Analysis of data Effect of width of vessel	172
	Flow through circular apertures from wide vessels	173 179
	Flow through jets	184
	The effect of restricting air entry	186
	Flow from flat-bottomed vessels through central slots	187
	Two regimes of flow from troughs through slots	188
	Blocked and Obstructed Apertures	193
	The empty annulus	193
	Blocked and obstructed apertures	198
	Discussion	202

Chapter 7 Conclusion	203
Biblography	207
Index of Names	213
Subject Indes	217
Other Titles in the Series	223