

The Ecology of Building Materials

Bjørn Berge

Translated from Norwegian by Filip Henley

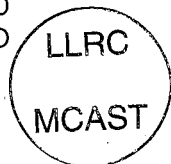
With Howard Liddell

To my three girls,
Marianne, Sofia Leiresol and Anna Fara



Architectural Press

AMSTERDAM BOSTON HEIDELBERG LONDON NEW YORK OXFORD
PARIS SAN DIEGO SAN FRANCISCO SINGAPORE SYDNEY TOKYO



contents

<i>Author's foreword</i>	vii	<i>Important factors in the physics of building materials</i>	58
<i>Foreword by Howard Liddell</i>	ix		
<i>Preface</i>	xi	Section 2	
<i>Introduction</i>	xiii	The flower, iron and ocean	
		<i>Raw materials and basic materials</i>	
Section 1			
Eddies and water-level markers			
<i>Environmental profiles and criteria for assessment</i>			
1 Resources	3	5 Water and air	65
<i>Material resources</i>	5	<i>Water</i>	65
<i>Energy resources</i>	15	<i>Air</i>	66
		6 Minerals	69
2 Pollution	25	<i>Metallic minerals</i>	69
<i>Types of pollution</i>	28	<i>Metals in building</i>	74
<i>Reduction of pollution in the production stage</i>	34	<i>Non-metallic minerals</i>	81
<i>Reduction of pollution during building use</i>	35	<i>Non-metallic minerals in building</i>	92
		7 Stone	107
3 Local production and the human ecological aspect	43	<i>Production of building stone</i>	111
<i>The production process, product quality and the quality of work</i>	45	8 Loose materials	117
<i>Technology</i>	48	<i>Loose materials in building</i>	119
<i>Economy and efficiency</i>	49	<i>Sand and gravel as aggregate in cement products</i>	121
		<i>Earth as a building material</i>	121
4 The chemical and physical properties of building materials	53	<i>Brick and other fired clay products</i>	128
<i>A small introduction to the chemistry of building materials</i>	54	9 Fossil oils	141
		<i>The basic materials</i>	144
		<i>Plastics in building</i>	147
		10 Plants	157
		<i>Living plants</i>	161
		<i>Timber</i>	163
		<i>Grasses and other small plants</i>	174
		<i>Building chemicals from plants</i>	176
		<i>Cellulose</i>	178

11 Materials of animal origin	179	Non-metallic surface materials	
12 Industrial by-products	183	(pre-formed or applied)	311
Section 3		Stone surface materials	318
The construction of a sea-iron		Fired clay sheet materials	323
flower		Earth surface materials	327
Building materials		Plastic-based sheet materials	327
13 Structural materials	189	Living plant surfaces	328
Metal structures	191	Wall cladding with plants	337
Concrete structures	192	Timber sheet materials	338
Stone structures	200	Straw and grass sheet materials	355
Structural brickwork	203	Soft floor coverings	361
Earth structures	209	Wallpapers	366
Plastic structures	221	16 Building components	375
Timber structures	222	Windows and doors	375
Peat walls	237	Stairs	382
The energy and material used by		17 Fixings and connections	385
different structural systems	238	Mechanical fixings	385
14 Climatic materials	243	Chemical binders	389
Thermal insulation materials	244	18 Paint, varnish, stain and	
Warmth-reflecting materials	247	wax	401
Moisture-regulating materials	248	The main ingredients of paint	404
Air-regulating materials	253	Paints with mineral binders	411
Snow as a climatic material	255	Paints with organic binders	415
Metal-based materials	258	19 Impregnating agents, and	
Materials based on non-metallic		how to avoid them	429
minerals	259	Choosing quality material	430
Fired clay materials	270	Structural protection of exposed	
Earth and sand as climatic materials	272	components	431
Bitumen-based materials	275	Methods of impregnation	433
Plastic materials	276	Oxidizing and exposure to the sun	434
Timber materials	278	Non-poisonous surface coats	434
Peat and grass materials	287	Poisonous surface-coats or	
Materials based on animal products	297	impregnation	435
Materials based on recycled textiles	305	The least dangerous impregnating	
15 Surface materials	307	substances	438
Metal surface materials	310	Index	443

Index

- Absorption principle, 250-3
 - hygroscopic materials, 251-3
- Acid pollutants, 32
- Acrylate:
 - adhesive, 395
 - paint, 416
- Adhesives, 391-9
 - animal glues, 395-7
 - mineral adhesives, 393-4
 - plant glues, 397-9
 - synthetic resins, 394-5
- Adobe (earth blocks), 217-18
- Aerogel, 267
- Aggregates, 194-5, 263-4
 - stabilizing aggregates, 210-11
- Air, 66-7
- Air cavity, 253
- Air moisture, 249-53
- Air permeability, 59
- Air-regulating materials, 243, 253-5
 - external windbreaks, 253-5
 - See also* Climatic materials
- Airtight membranes, 254-5
- Alcohols, 146
- Aldehydes, 146
- Aliphatic hydrocarbons, 144-5
- Alkenes, 146
- Alkyde oil, 416-17
- Alpha radiation, 55
- Aluminium, 73, 74, 77-8, 191
 - as climatic material, 259
 - doors, 382
 - windows, 382
- Amines, 146
- Ammonia, 66-7
- Anhydrite, 90
- Animal products, 179-81
 - as climatic materials, 297-305
 - glue, 395-7
 - paint, 418-19
- Aromatic hydrocarbons, 144-5
- Arsenic, 81
- Asbestos, 86, 92
 - use on turf roofs, 334
- Asphalt, 141, 143, 144
- Assembly for disassembly (ADISA), 12-15
- Atomic weight, 54
- Bakelite plastic, 149
- Ball test, 125
- Bark extract, 439
- Batten flooring, 350
- Bauxite, 73, 77-8
- Beeswax, 180, 426
- Bentonite, 335
- Beta radiation, 55
- Binders, 389-99
 - cement, 94-7
 - concrete, 193-4
 - lime, 86, 92
 - mortars, 202, 325-6, 389-91
 - paint, 404
- Birch bark, 287
 - use on turf roofs, 334
- Bitumen, 144
 - as climatic material, 275
 - use on turf roofs, 334
- Blast furnace slag, 95, 96, 185

- Blood albumin glue, 397
- Blue clay, 7
- Boarding:
- from waste products, 361
 - peat, 295-7
 - plant materials, 359-61
 - cellulose, 286-7
 - timber, 351-5
- Bogpeat, *See* Peat
- Bolts, 386-7, 388
- Bor salts, 440
- Boracid, 440
- Borax, 92, 440
- Boron, 86
- Brass, 79
- Breathing walls, 255
- Bricks, 119, 120, 128-34, 205, 323
 - as climatic material, 270
 - as structural material, 203-9
 - smaller brick structures, 208-9
 - floors, 326-7
 - history, 128-9
 - manufacture, 129-34
 - drying, 131
 - energy consumption, 138-9
 - firing, 131-4
 - forming, 130
 - recycling, 139, 207-8
 - stairs, 384
- Bronze, 78-9
- Bulwark, 229
- Butadiene, 395
- Cadmium, 80
- Calcium silicate sheets, 315, 316
- Caoutchouc, 157-8
- Carbon, 58, 75, 76
- Carbon dioxide, 32, 142, 160-1
- Carpets, 364-6
- Casein, 180
 - glue, 397
 - paint, 419
- Cast iron, 75
 - stairs, 384
- Casting, 102-3
- Cavity walls, 253
- Cellulose, 158, 178
 - as climatic material, 278-9, 285-7
 - cellulose fibre, 285-6
 - cellulose paper and boards, 286-7
 - glue, 398
 - paint, 423
 - sheeting, 312-13, 315
- Cement, 83, 86, 92-100, 121
 - additives, 97, 98
 - as climatic material, 260, 262-4
 - earth stabilization, 211
 - energy use in production, 99-100
 - history, 93-4
 - hydraulic binders, 94-6
 - non-hydraulic binders, 96-7
 - pollution and, 97-9
 - render, 318
 - lime cement render, 318
 - roof materials, 312, 313
 - sheeting, 315
 - See also* Concrete
- Cement paints, 415
- Centralization, 50
- Ceramic tiles, 119, 120, 135-8, 323-4, 325
 - manufacture, 136
- Chalk, 57, 86
- Chamotte, 131
- Chemical oxygen depletion (COD), 33
- Chemical properties of building materials, 53-8
 - chemical reactions:
 - supply and release of energy, 56-7
 - weights of different substances, 55-6
 - radioactivity, 55
 - relative atomic weight, 54
- Chipboard, 340, 351-2, 354
- Chlorinated biphenyls (PCBs), 145, 276, 376
- Chlorinated hydrocarbons, 145
- Chlorofluorocarbons, 145-6
- Chloroprene, 395
- Cholofonium, 177, 422
- Chrome, 73, 74, 80
- Cladding, 307
 - ceramic tiles, 325
 - eelgrass, 359
 - grass, 357
 - living plants, 337
 - metals, 310
 - stone, 322
 - straw, 358
 - timber, 345-9
 - wall tiles laid in mortar, 325
 - See also* Sheeting

- Clay, 95, 119, 120, 128
 as climatic material, 270–2, 274
 calcined, 95
 expanded clay production, 136–8
 surface materials, 323–7
See also Bricks; Ceramic tiles
- Clay blocks, 205
- Cleft log roof, 342–3
- Climatic materials, 243–306
 air-regulating materials, 253–5
 animal products, 297–305
 bitumen-based materials, 275
 earth/sand, 272–5
 fired clay materials, 270–2
 foamed quartz, 267
 foamglass, 268
 fossil meal products, 265
 grass materials, 287–92
 gypsum products, 264–5
 metal-based materials, 258–9
 moisture-regulating materials, 248–53
 montmorillonite, 269–70
 peat materials, 287–9, 292–7
 perlite products, 265–6
 plastic materials, 276–8
 pumice products, 265–6
 recycled textiles, 305–6
 snow, 255–8
 synthetic mineral wool fibres, 268–9
 thermal insulation, 244–7
 timber materials, 278–87
 vermiculite products, 266–7
 warmth-reflecting materials, 247–8
- Climbing plants, 162–3
- Coal tar, 144, 334
- Cobalt, 5, 81
- Collagen, 396
- Compressive strength, 59
 earth building, 126–7
- Concrete, 121, 192–9
 as climatic material, 260, 262–4
 aerated concrete, 262–3
 foamed concrete, 262
 with light aggregate, 263–4
 composition, 193–6
 additives, 195
 aggregates, 194–5
 binders, 193–4
 lime sandstone, 196
 reinforcement, 195
 sulphur concrete, 196
 durability, 196–7
 floor coverings, 313–14
 recycling, 197–9
 roof materials, 311, 312
 stairs, 384
- Condensation, 250
See also Moisture-regulating materials
- Copal, 157
- Copper, 73, 74, 78–9
 as climatic material, 259
 extraction, 3
- Cork oak, 282
- Corrosion, 74
 protection against, 76–7
- Craftsmen, 43–4
- Creosote, 436, 438
- Critical minerals, 5
- Crown glass, 103
- Decentralized production, 18, 49
- Dibutyl phthalate (DBP), 395
- Dichloroethane, 145
- Dolomite, 90
- Doors, 375
 aluminium, 382
 plastic, 382
 timber, 380–2
- Double curved shells, 236
- Down-cycling, 143
- Dry-stone walling, 202
- Drying oils, 177
- Durability, 8–10
 climate effects on, 9–10
 concrete, 196–7
 plastic products, 154–6
 timber, 171–2
- Dust:
 carpets and, 365
 pollution, 28
- Earth building, 120, 121–8, 209–21
 climatic properties, 273–4
 construction methods, 212–20
 adobe (earth blocks), 217–18
 pisè (earth ramming technique),
 212–17
 earth preparation, 127
 earth surface materials, 327
 efficiency of, 220–1

- Earth building (*contd*)
 history, 123-4
 indoor climate and, 221
 moisture and shrinkage, 127
 raw materials, 124-5, 210
 stabilizing aggregates and other additives, 210-12
 technical properties, 125-7
- Earth loaves, 219-20
- Ecological building industry, principles for, 49-52
- Economical construction, 7-8
- Eelgrass, 358-9
- Efficiency, 50
 of earth building, 220-1
- Electromagnetic radiation, 33-4
- Elements, 54, 58
- Emulsion paint, 423-4
- Endothermic reactions, 57
- Energised water, 66
- Energy consumption:
 cement production and, 99-100
 fired clay products and, 119, 138-9
 in building materials, 16-17
 in metal extraction, 71
 reduction of in building industry, 18-24
 stone production and, 110
 structural systems, 238-42
- Energy pollution, 25-6
- Energy recovery, 12
- Energy resources, 15-24
See also Energy consumption
- Engineer-run production, 44-5
- Epoxide:
 adhesive, 395
 paint, 416
- Esters, 146
- Ether alcohols, 146
- Etheric oils, 177
- Ethylene vinyl acetate (EVA) adhesive, 394, 395
- Eutrophating substances, 33
- Exothermic reactions, 57
- Extended earth tubes, 220
- Extinction rate, 25
- Extraction:
 loose materials, 119
 metals, 71
 aluminium, 77-8
 copper, 79
 iron, 75-6
 zinc, 79
 non-metallic minerals, 83-4
 raw materials for earth building, 124-5
 stone, 110-11, 112-13, 200
- Felt products, 298
- Fertilizer pollution, 33
- Fibreboard, 352, 353-4
- Fibreglass, 268
- Figure-of-eight test, 125-6
- Fillers, 391, 399
 paint, 410
- Fired clay materials, *See* Bricks; Ceramic tiles; Clay
- Fish oil, 421-2
- Fixings, 385-9
 metal, 387-9
 timber, 386-7
- Flagstones, 201
- Flashings, 335-6
- Flax, 159
- Flint, 5
- Float glass, 103, 376
- Floating floors, 350
- Floor base, 351
- Floors, 235, 308-10, 311
 concrete coverings, 313-14
 fired clay materials, 325-6
 bricks laid in sand, 326-7
 tiles laid in mortar, 325-6
 floating, 350
 health and, 309-10
 metals, 310
 peatstone floor tiles, 314
 soft coverings, 361-6
 carpets/textiles, 364-6
 linoleum, 361-2
 natural rubber (latex), 362-3
 plastic, 363
 synthetic rubber, 363-4
 stone materials, 320, 322-3
 timber, 349-51
- Fly-ash, 185
- Foamed concrete, 262
- Foamed quartz, 267
- Foamglass, 260, 268

- Forestry, 164–71
 drying, 170–1
 felling, 168
 splitting, 168–70
 storage, 168
 See also Timber
- Formaldehyde adhesives, 394–5
- Fossil meal, 91, 95, 129–30, 185
 as climatic material, 265, 271
- Foundations, 228–30
- Fungi, 429–30
- Fungicides, paint, 410–11
- Galvanized steel sheeting, 258
- Galvanizing, 76–7
- Gamma radiation, 55
- Gangnailplates, 388
- Gas diffusion, 255
- Gas resources, 15
- Gelatine, 396
- Genetic pollution, 34
- Geodesic domes, 236–7
- Glass, 100–5, 376–7
 foamglass, 260
 history, 100–1
 production of, 102–5
 casting, 102–3
 crown glass, 103
 ecological aspects, 104–5
 float glass, 103
 machine glass, 103
 smelting, 102
 table glass, 103
- Glasswool, 260, 268, 269
- Global recycling, 14–15
- Global warming potential (GWP), 32
- Glues, *See* Adhesives
- Glycerols, 177
- Gold, 81
- Granite, 69, 319, 320
- Grasses, 162, 174–6
 as climatic materials, 287–92
 loose fill, 289–90
 matting, 291
 straw bales, 290–1
 strawboards, 291–2
- cladding, 357
 cultivating and harvesting, 175
 grass sheet materials, 355–7
 preparation, 175–6
 turf, 161–2
 roofs, 328–37
- Gravel, 108, 119, 121, 194
- Green soap, 426–7
- Green vitriol, 440
- Greenhouse effect, 16, 32, 159
- Greenhouse gases, 32
- Ground moisture, 249
- Guillotining, stone, 114
- Gypsum, 83, 90, 97, 183–4, 315–16
 as climatic material, 264–5
 render, 318
- Heat capacity, 59
- Heavy metals, 27, 28
- Hedge plants, 162, 163
- Hindsight principle, 34
- Hoffman kiln, 133
- Hygroscopic materials, 251–3
- Hyperlite, 266
- Ice, 66
- Igneous stones, 107
- Impregnation, 433–4
 pH-regulating, 435
 poisonous, 435–8
- Industrial by-products, 183–5
- Insect pests, 429–30
- Insulation, *See* Temperature-regulating materials
- Iron, 73, 74–7
 corrosion protection, 76–7
 extraction, 75–6
 stairs, 384
- Isocyanate adhesive, 395
- Joints, 386
- Kaolin, 83
- Ketones, 146
- Kilns, 131–4, 136–7
- Laminate products, 340
- Latex floor coverings, 362–3
- Lazure, 402
- Lead, 73, 74, 79–80
 as climatic material, 259
 pollution, 72

- Leichtlehm, 289–90
 Lignin, 177
 Lime, 57, 84, 86–90, 92–100
 binders, 86, 92
 calcined, 95
 earth stabilization, 211
 history, 93–4
 hydraulic, 95
 pozzolana cements, 95–6
 renders, 312, 316, 317–18
 lime cement render, 318
 Nepalesian render, 317
 on earth walls, 317
 pozzolana render, 317–18
 slaking, 87–90, 95
 Lime paint, 412–14
 Lime sandstone, 196
 Limestone, 83
 Linoleum, 361–2
 Linseed oil, 419–21
 putty, 292
 Log construction, 231–2
 Loose materials, 117–21
 See also Clay; Earth building; Gravel;
 Sand
 Loss factor, 8
 Lye, 439–40
 Machine glass, 103
 Magnesium, 73, 74, 81, 84
 Manganese, 80
 Manufacturing methods, 43–5
 Marsh-prairie grass, 334
 Masonry, 202–3
 Mastics:
 bituminous, 275
 plastic, 276, 277
 Material pollution, 25, 26
 Material resources, 5–15
 in world context, 15
 reduction of use of, 7–15
 economical construction, 7–8
 high durability, 8–10
 in production process, 6–7
 reduced loss of building materials,
 8
 See also Recycling
 use in structural systems, 238–42
 Matting, 291, 295, 297–8
 Metals, 69–81
 climatic materials, 258–9
 fixings, 387–9
 recycling, 71, 73–4
 reserves, 73–4
 structural materials, 191–2
 surface materials, 310–11
 See also Specific metals
 Metamorphic stones, 107
 Mica, 91, 266
 Mineral adhesives, 393–4
 Moisture, 248–9
 air moisture, 249–53
 infestation and, 431–3
 Moisture-regulating materials, 243, 248–53
 air moisture, 249–53
 absorption principle, 250–3
 air cavity method, 253
 vapour barriers, 250
 See also Climatic materials
 Monomaterials, 14
 Montmorillonite, 91, 261, 269–70
 Moraine, 117
 Mortars, 202, 325–6, 389–91
 Moss, 293–5
 Nailed floors, 350
 Nails, 387–8
 Naphtha, 145, 147
 Natural fibres, earth stabilization, 211
 Nepalesian lime rendering, 317
 Nickel, 80
 Nitric oxide, 32
 Nitrogen, 66
 Noise-regulating materials, 243
 See also Climatic materials
 Non-renewable resources, 3
 Non-usable resources, 3
 Nuclear power, 15–16
 Oil, 5, 141–4
 products, 144–7
 resources, 15, 142
 See also Plastics
 Olefines, 146
 Open charcoal kilns, 132–3
 Ores, 70–1
 Oxidization, of timber, 434
 Oxygen, 66–7

- Ozone-reducing substances, 28–32, 145–6
- Packaging, 8
- Paint, 401–24
- application, 404
 - cellulose paints, 423
 - cement paints, 415
 - drying oils, 419–22
 - emulsion, 423–4
 - history, 403–4
 - ingredients, 404–11
 - additives, 409–11
 - binders, 404
 - pigments, 406–9
 - solvents, 404–6
 - lime paint, 412–14
 - natural resins, 422–3
 - protein glue paint, 418–19
 - silicate paints, 414–15
 - starch paint, 423
 - synthetic resins, 415–18
 - tar, 422
- Panelling, 345, 346–7, 431–2
- Paper, as climatic material, 279, 286
- wool-based, 298–9
- See also* Wallpapers
- Paper plastics, 276, 277
- Parquet, 351
- Peat:
- as climatic material, 287–9, 292–7
 - external waterproofing, 295
 - matting, 295
 - moss, 293–5
 - peat blocks, 293
 - peat boards, 295–7
 - peat fibres, 293
 - walls, 237
- Peatstone floor tiles, 314
- Perlite, 91, 265–6
- Permeability:
- air, 59
 - vapour, 60
- Permetrine, 436, 438
- pH values, 65
- regulating surface coats, 435
- Phaedomorphosis, 48
- Phenol, 394
- Photochemical oxidizing agents, 33
- Photochemical ozone creation potential (POCP), 33
- Phthallic acid esters, 146
- Physical properties of building materials, 58–60
- Pigments, 406–9
- Pins, 386–7
- Pisè (earth ramming technique), 212–17
- Plank roof, 343
- Plant materials:
- boarding, 359–61
 - concrete reinforcement, 195
 - glues, 397–9
- See also* Cellulose; Starch
- Plants, 157–78
- building chemicals from, 176–8
 - climbing plants, 162–3
 - hedges, 162, 163
 - indoor, 338
 - turf, 161–2
 - roofs, 328–37
 - wall cladding, 337–8
- See also* Grasses; Timber
- Plasterboard, 315, 316
- Plastics, 141, 142, 147–56
- as climatic materials, 276–8
 - insulation materials, 277–8
 - mastics, 276, 277
 - sealing strips, 277, 278
 - as structural materials, 221–2
 - as surface materials, 327–8
 - cellulose-based, 178
 - doors, 382
 - durability, 154–6
 - floor coverings, 363
 - pollution and, 142, 143, 149–52
 - recycling, 143, 156, 278
 - use on turf roofs, 335
 - wallpapers, 368
 - windows, 382
- Plywood, 354–5
- Podel mixture, 274
- Pollution, 25–41
- acid substances, 32
 - cement products and, 97–9
 - dust, 28
 - electromagnetic radiation, 33–4
 - environmental poisons, 28
 - eutrophicating substances, 33

- Pollution (*cont'd*)
 fired clay products and, 119, 120
 forests and, 159
 genetic pollution, 34
 glass production and, 104-5
 greenhouse gases, 32
 metals and, 72
 extraction, 71
 ozone-reducing substances, 28-32
 photochemical oxidizing agents, 33
 physical encroachment of nature, 34
 plastics and, 142, 143, 149-52
 reduction of during building use, 35-41
 reduction of in production stage, 34-5
 Polychlorinated biphenyls (PCBs), 145, 276, 376
 Polycyclical aromatic hydrocarbons (PAHs), 35, 144, 275
 Polyethylene (PE), 152, 276, 277
 Polyisobutyl sheeting, 276
 Polymers, 149
 Polyolephine floor coverings, 363
 Polypropylene (PP), 152, 276, 277
 Polystyrene (PS), 152
 Polyurethane (PUR), 153
 adhesive, 395
 paint, 416
 Polyvinyl acetate (PVAC):
 adhesive, 394, 395
 paint, 417-18
 Polyvinyl chloride (PVC), 149, 153-4, 276, 277
 Portland cement, 92, 93, 95-6
 pozzolana cements, 96
 Potash, 439-40
 Potassium carbonate, 177-8
 Potassium chloride, 83, 91
 Pozzolana cements, 93, 94, 100
 earth stabilization, 211
 lime pozzolana render, 317-18
 Portland, 96
 Primary energy consumption (PEC), 16, 25
 Primary relationship, 45-8
 Production process, 43-8
 economy and efficiency, 49-52
 primary relationship, 45-8
 technology and, 48-9
 Pumice, 265-6
 Purple snail, 181
 Quarrying, 112-13
 Quartz, 83
 foamed quartz, 267
 Radioactive pollution, 33-4
 Radioactivity, 55
 Raft and pile foundations, 229-30
 Rain, 249
 Raw materials:
 reserves, 3, 4
 metals, 73-4
 resources, 4
 Re-use, 11, 14
 Recycling, 6, 7, 10-15, 40
 assembly for disassembly (ADISA), 12-15
 bricks, 139, 207-8
 concrete, 197-9
 levels, 11-12
 metals, 71, 73-4
 plastics, 143, 156, 278
 textiles, 305-6
 timber, 172-4
 Reinforced concrete, 195
 Relative atomic weight, 54
 Renders, 312, 316-18
 cement, 318
 gypsum, 318
 lime, 312, 316, 317-18
 sulphur, 318
 Renewable resources, 3, 7, 19
 Reserves, of raw materials, 3, 4
 metals, 73-4
 Resins:
 natural, 422-3
 synthetic:
 adhesives, 394-5
 paints, 415-18
 Resources, 3-24
 See also Energy resources; Material resources
 Rockwool, 260, 268-9
 Roofs, 235-7, 307
 concrete tiles, 311
 fired clay materials, 323, 324-5
 grass cladding, 357
 metals, 310-11
 non-metallic materials, 312-13
 slate tiles, 319, 320-2

- thatch, 355, 357–9
- timber, 235–7, 341–5
 - cleft log roof, 342–3
 - plank roof, 343
 - shakes, 344
 - shingles, 344
 - Sutak roof, 343
- turf roofs, 328–37
- Rotating kilns, 136–7
- Rubber floor coverings:
 - latex, 362–3
 - synthetic, 363–4
- Russian glass, 100
- Rye flour filler, 399

- Sand, 119, 121, 194
 - as climatic material, 274
 - use in brick manufacture, 129
- Sandbag technique, 220
- Sawdust, 280–2
- Screws, 388
- Sealed unit glazing, 376, 377
- Sealing strips, 277, 278
- Secondary relationship, 45
- Sedimentary stones, 107
- Self-climbing plants, 162
- Shakes, 344, 347–8
- Sheeting, 314–16
 - calcium silicate, 315
 - cellulose roof sheeting, 312–13
 - cement-based, 315
 - galvanized steel, 258
 - plasterboard, 315
 - plastic-based sheet materials, 327–8
 - polyisobutyl, 276
 - stainless steel, 258
 - timber sheet materials, 338–55
- Shell structures, 235–7
 - double curved shells, 236
 - geodesic domes, 236–7
- Shingles, 344, 347–8
- Silica dioxide, 85
- Silicates, 177
 - dust, 185
 - paints, 414–15
- Silicic acid, 267
- Silicone, 90
- Silicium dioxide, 90
- Slaked lime, 87–90, 95

- Slate, 108
 - sorting/cutting, 114–15
 - tiles, 318–19, 320–2
- Smelting, 102
- Smog, 33
- Snail, purple, 181
- Snow, as climatic material, 255–8
- Soap, 426–7
- Soda, 439–40
- Sodium chloride, 83, 91
- Solvents, 144, 147
 - paint, 404–6
- Soya glue, 398
- Stainless steel sheeting, 258
- Stains, 401–3, 424–6
- Stairs, 382–4
- Starch, 158, 177
 - glue, 398–9
 - paint, 423
- Static electricity, carpets and, 365
- Stave construction, 232
- Steel, 74–7, 191
 - concrete reinforcement, 195
 - corrosion protection, 76–7
 - galvanized steel sheeting, 258
 - stainless steel sheeting, 258
- Stone, 7, 69, 107–16, 200–3
 - as surface material, 318–23
 - floor covering, 322–3
 - roof covering, 320–2
 - wall cladding, 322
 - crushed stone, 115–16, 194
 - dividing/cutting, 113–14
 - extraction, 110–11, 112–13, 200
 - stairs, 383–4
- Stovewood houses, 232
- Straw, 355
 - bales, 290–1
 - cladding, 358
 - strawboards, 360
 - thatch, 355, 357–8
- Strawboards, 291–2
- Structural materials, 189–242
 - bricks, 203–9
 - concrete, 192–9
 - earth structures, 209–21
 - energy/material use, 238–42
 - environmental profiles, 242
 - metal structures, 191–2

- Structural materials (*cont'd*)
 peat walls, 237
 plastics, 221-2
 protection from infestation, 431-3
 stone, 200-3
 timber, 222-37
- Styrene, 395
- Sugar, 158
- Sulphur, 91, 184-5
 concrete, 196
 render, 318
- Sulphur dioxide, 32, 142, 184
- Surface materials, 307-73
 earth, 327
 floor coverings, 313-14, 322-3, 361-6
 living plant surfaces, 328-38
 turf roofs, 328-37
 wall cladding, 337-8
 metals, 310-11
 render, 316-18
 roofing materials, 312-13, 320, 328-37, 341-5
 sheeting, 314-16
 fired clay sheet materials, 323-7
 grass sheet materials, 355-7, 358-9
 plastic-based sheet materials, 327-8
 timber sheet materials, 338-55
 stone, 318-23
 straw, 355-6, 357-9, 360
 wallpapers, 366-73
See also Cladding
- Sutak roof, 343
- Table glass, 103
- Tar, 141, 143, 144
 use on turf roofs, 334
 wood tar, 157, 176-7, 422, 438-9
- Technology, 48-9
- Temperature-regulating materials, 243, 244-8
 thermal insulation materials, 244-7
 dynamic insulation (DI), 244-6
 insulation value, 246-7
 static insulation (SI), 244
 warmth-reflecting materials, 247-8
See also Climatic materials
- Tensile strength, 59
 earth building, 125
- Terrazzo floor tiles, 314
- Textiles:
 floor coverings, 364-6
 wallpapers, 366-8
- Thatch, 355, 357
 eelgrass, 358-9
 straw, 357-8
- Thermal conductivity, 59
- Thermal insulation, *See* Temperature-regulating materials
- Thermoplastics, 149
- Thermosetting plastics, 149
- Timber, 157, 163-74, 222-37
 as climatic material, 278-87
 birch bark, 287
 cellulose fibre, 285-6
 cellulose paper and boards, 286-7
 cork oak, 282
 sawdust, 280-2
 wood fibre boards, 285
 wood shavings, 280-2
 woodwool cement, 282-5
 as surface material, 338-55
 boarding, 351-5
 cladding, 345-9
 doors, 380-2
 durability, 171-2
 fixings, 386-7
 floor structures, 235, 349-51
 foundations, 228-30
 history, 223
 protective measures, 430-2
 burning the outer wood, 434
 cleaning out the contents of the cells, 433
 least dangerous impregnating substances, 438-40
 non-poisonous surface coats, 434-5
 oxidizing and sun exposure, 434
 poisonous surface coats, 435-8
 self-impregnation, 433
 recycling, 172-4
 roof structures, 235-7, 341-5
 stairs, 382-3
 structural elements, 223-6
 walls, 231-4, 345-9
 tropical timber, 159-61
 windows, 377-80
See also Forestry
- Titanium, 81

- Transport, energy consumption and, 16–17
Trees, *See* Forestry; Timber
Trellis-climbing plants, 162–3
Trief-cement, 96
Trinidad asphalt, 144
Tropical timber, 159–61
Tunnel kilns, 134
Turbulence membranes, 254
Turf, 161–2
 roofs, 328–37
Turpentine, 406
- Under-developed countries, 15
Underground buildings, 272–4
Unused resources, 5, 6–7
Usable resources, 3
Used resources, 5
- Vapour barriers, 250
Vapour permeability, 60
Varnish, 401–3
Vermiculite, 91, 266–7
Vinyl floor coverings, 363
Vitrifying kilns, 136
- Wallpapers, 366–73
 history, 367–8
 types of, 368–73
Walls:
 breathing, 255
 cavity walls, 253
 dry-stone walling, 202
 peat, 237
 timber, 231–4
 See also Cladding
Warmth-reflecting materials, 247–8
Waste products, 6–7, 26–7, 74
 boarding production, 361
 management of, 34–5
 metals, 72
 oil-based products, 143–4
 plastics, 154, 221–2
 recycling, 7
Water, 54, 65–6
 as resource, 3
 energised, 66
 See also Moisture-regulating materials
Waterglass, 212, 393–4
 as pH-regulating surface coat, 435
 paints, 414–15
Wattling, 234, 348–9
Wax, 180, 402, 426
Wedging, stone, 113
Wet-formed walls, 218–19
Windbreaks, 254
Windows, 375–80
 aluminium, 382
 plastic, 382
 sustainable window, 379
 timber, 377–80
Wood, *See* Timber
Wood fibre boards, 285
Wood shavings, 280–2
Wood tar, 157, 176–7, 422, 438–9
Wood vinegar, 176, 439
Woodwool cement, 282–5
Wool, 180, 297–305
 building paper, 298–9
Work satisfaction, 46–8
- Zinc, 73, 74, 79
 as climatic material, 259
Zincing, 76–7
Zytan blocks, 270