Ernst and Peter Neufert

Architects' Data
Fourth Edition

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Using this book

This book provides architects and designers with a concise source of the core information needed to form a framework for the detailed planning of any building project. The objective is to save the designers of buildings time during their basic investigations. The information includes: principles of the design process, basic information on siting, constructing and servicing buildings, as well as illustrations and descriptions of a wide range of building types. Architects need to be well informed about the requirements for all the constituent parts of new projects, to ensure that their designs satisfy their clients and the buildings conform to accepted standards and regulations.

The contents list shows how the book is organised and the order of the subjects discussed.

To avoid repetition and keep the book to a manageable length, the different subjects are covered only once in full. Readers should therefore refer to several sections to glean all the information they require. For instance, an architect wanting to prepare a scheme for a college will need to refer to sections other than that on universities and colleges, such as: drafting guidelines; multi-storey buildings; various sections on services and environmental control; catering; residential buildings, hotels and flats (for student accommodation); office buildings (for working environments); libraries; car parks; accessible building; indoor and outdoor sports facilities; gardens; details on doors, windows, stairs and other building components; the section on construction, and more.

Readers should note that most of the material is from European (substantially German) contributors. This means, for example, that information on climate and daylight is from the perspective of a temperate climate in the northern hemisphere. The actual conditions at the site of a proposed building will always have to be ascertained. Similarly, in the section on roads, illustrations show traffic driving on the right-hand side.

References to standards, regulations and guidelines reflect the book's origins. For this translation, the publishers took the decision to leave the specific text references to German standards, regulations and guidelines in place, to indicate where similar standards, regulations and guidelines might exist in other jurisdictions. Users elsewhere must familiarise themselves separately with such national and local legislation and guidance. Again, local conditions must be taken into consideration for each individual case.

The terminology and style of the text is UK English, which will need to be taken into account by readers accustomed to American English. These readers will need to be aware that, for example, 'lift' has been used instead of 'elevator' and 'ground floor/first floor' instead of 'first floor/second floor'.

The data and examples included in the text are drawn from a wide range of sources; as a result a variety of conventions for dimensions is used throughout. The measurements shown are all metric but a mixture of metres, centimetres and millimetres is used (and sometimes not identified).

Readers will also find some superscript numbers associated with measurements. When these appear by dimensions in metres with centimetres, for instance, they represent the additional millimetre component of the measure (e.g. 1.26^{5} denotes 1 m, 26 cm, 5 mm). Anyone familiar with the metric system will not find this troublesome. Those people less comfortable with metric units can use the conversion tables (to imperial measures) at the end of the book.

The plans and diagrams of buildings do not have scales as the purpose here is to show the general layout and express relationships between different spaces, making exact scaling unnecessary. However, all relevant dimensions are given on the detailed drawings and diagrams of installations, to assist in the design of specific spaces and constructions.

To help readers identify relevant background information, details of British Standards Institute (BSI) and German Institute of Standardisation (DIN) building-related standards are provided in two types of location. At the end of the book is a selected list of BS and DIN standards, arranged broadly by topic. Additionally, the margin of many pages of the main text contains relevant BS and DIN codes. Please note that, if a British or German code includes EN or ISO (signifying European or international), there is automatically a German or British counterpart with the same code and title.

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Contents

Foreword xii

BASICS

Abbreviations and symbols 1
SI units 2

Drawings
Paper formats 4
Technical drawings 5
Layout of drawings 6
Construction drawings 7
Construction drawing symbols 8
Water supply and drainage symbols, ... 12
Electrical installation symbols 14
Security installation symbols 17
Gas installation symbols 18
Drawing by hand 19
Computer-aided drawing 20

Accessible Building
Dimensions for wheelchair users 21
Accessible public buildings 22
Accessible housing 23

Dimensional Basics and Relationships
Man as measure and purpose 26
The universal standard 27
Body measurements and space requirements 28
Geometrical relationships 30
Dimensions in building 34

Building Biology
Basics 36
Room climate 37
Electromagnetic fields 38

Visual Perception
The eye 39
Perception of colour 41

DESIGN PROCESS

Design
What is design? 42
Planes of reference 43
Questionnaire 44

Sustainable Building
General, design, construction 46
Operation, demolition 47

Facility Management
Background 48
Methods 49

Refurbishment
Conservation and alteration 50
Care of historic monuments 51
Listed building protection 52
Recording of old buildings 53
Conversion 54

Design and Construction Management
Public building and planning law 56
Private building law, VOB, HOAI 57
Work phases 58
Measures of building use 63
Setback areas 64
Construction costs 65

BUILDING COMPONENTS

Foundations
Building excavations 66
Foundations 69
Tanking, basement drainage 71
Repair 73

Walls
Natural stone masonry 74
Brick and block masonry 75
Composite construction 78
Repair 79

Floor Slabs
Slab construction 80
Refurbishment 81
Concrete repair 82
Floors 83

Roofs
Roof shapes 85
Pitched roofs 86
Flat roofs 91

Windows
Arrangement 96
Requirements 97
Design types 98
Thermal insulation 99
Sound insulation 100
Cleaning buildings 101
Loft windows 102
Skylights and dome rooflights 103

Glass
Basics 104
Insulated glazing 105
Security and noise control glass 107
Optically variable glass 108
Cast glass 108
Glass doors 108
Profiled glass 109
Glass blocks 110
Fire protection glazing 111
Curtain walling 112

Doors
Arrangement 113
Constructional details 114
Special doors 115
Garage/industrial doors 116
Lock suites 117
Security of buildings and grounds 118

Stairs
Principles 120
Regulations 121
Construction 122
Ramps, spiral stairs 123
Access and escape ladders 125

Escalators
For shops and offices 126

Moving Walkways
For shops and offices 127

Lifts
Principles 128
Control equipment 129
Passenger lifts for residential buildings 130

Passenger lifts for offices, hotels, banks ... 131
Small goods lifts ... 132
Hydraulic lifts ... 133
Special lifts ... 134

RESIDENTIAL BUILDINGS

Basics
Design basics ... 135
House-building policy ... 136

Housing Density
Parameters ... 137

Orientation
Layout of buildings ... 138

Access
Detached and terraced development ... 139
Deck access ... 140
Stepped houses ... 141
Vertical access ... 142

Floor Plans
Houses ... 143
Flats ... 145

Rooms
Access ... 146
Kitchens ... 149
Living areas ... 154
Bathrooms ... 160
Subsidiary rooms ... 162
Garages and carports ... 166

ACCOMMODATION

Student Residences
General design notes ... 167

Elderly People's Accommodation
Retirement flats ... 168
Nursing and care homes ... 169
Examples ... 170

Hotels
Basics ... 171
Rooms ... 172
Examples ... 173

Catering
Restaurants ... 174
Dining rooms, serving ... 176
Fast food outlets ... 177
Restaurant kitchens ... 178
Large kitchens ... 181
Examples of large kitchens ... 183

Youth Hostels
General design notes ... 184

Holiday/Weekend Cabins
General design notes ... 185

Motels
General design notes ... 186

Camping
General design notes ... 187

EDUCATION AND RESEARCH

Children's Daycare
Access and building layouts ... 188
Rooms, outdoor areas ... 189

Playgrounds
Playground equipment ... 190

Schools
General classrooms ... 191
Specialist classrooms ... 192
Information and communal area ... 193
Sanitary facilities, break and circulation area ... 194
Arrangement of classrooms, clusters ... 195
Model room programmes for primary schools ... 196
Examples ... 197

Universities and Colleges
Lecture theatres ... 198
Examples of lecture theatres ... 200
Seating and projection ... 201
Seminar and service rooms ... 202
Laboratories ... 203

CULTURAL VENUES

Museums and Art Galleries
General ... 207
Display rooms ... 208

Theatres
Historical review ... 209
Typology ... 210
Auditorium ... 211
Seating ... 212
Stage ... 213
Subsidiary rooms ... 215
Workshops and staff rooms ... 216
Rehearsal and public rooms ... 217
Modernisation and extension ... 218

Concert Halls
Origins, variants ... 219
Technical requirements, organ, orchestra ... 220
Acoustics ... 221

Cinemas
Projection ... 222
Auditorium ... 223
Multiplex cinemas ... 224
Multiplex cinemas, examples ... 225
Drive-in cinemas ... 226

Circus
Stationary ... 227

Zoos
Basics ... 228
Keeping animals ... 229
Enclosures ... 230

ADMINISTRATION AND OFFICES

Office Buildings
Structures ... 231
Tendencies/criteria ... 232
Typology until 1980 ... 233
Typology since 1980 ... 234
Space requirement ... 235
Computer workstations ... 236
Archives ... 237
Additional areas ... 238
Room typology ... 239
Grid ... 240
Access ... 241
Building services ... 242
Construction ... 243

High-Rise Buildings
Basics ... 244
Construction ... 245
Requirements ... 246

Libraries
Basics ... 247
Fittings ... 249
Space requirement ... 250
Scientific libraries ... 251
Archives ... 252

Banks
Banks ... 253

RETAIL

Retail Outlets
Guidelines and typologies ... 254
Retail regulations ... 255
Entrances and shop windows ... 256
Checkout and waiting zones ... 257
Waiting zones – examples ... 258
Routeing, escalators ... 259
Fittings – dimensions ... 260
Food shops ... 261
Self-service shops ... 262

INDUSTRY AND TRADE

Industry
Basics ... 263
Shed construction ... 265
Multi-storey industrial buildings ... 266
Transport ... 267
Warehousing ... 268
Subsidiary rooms ... 270
Examples ... 273

Workshops
Joinery ... 274
Carpenter's shop ... 275
Metalwork ... 276
Vehicle repairs ... 277
Bakery ... 278
Meat processing plant ... 279
Other trades ... 280
Laundry ... 281
Fire station ... 283

RELIGIOUS BUILDINGS

Christian Churches
Liturgical elements ... 285
Furnishing, vestry ... 286
Bell towers ... 287

Synagogues
General design notes ... 288

Mosques
General design notes ... 289

HEALTH

Doctors' Practices
Single and group practices ... 290

Hospitals
General, modular grid ... 291
Building design ... 293
Examples ... 294
Corridors, doors, stairs, lifts ... 295
Operational areas ... 296
Outpatient area ... 297
Outpatient medical centre – example ... 298
Examination and treatment ... 299
Care ... 305
Administration, social services ... 312
Supply and waste disposal ... 313
Technical supply ... 316

SPORT AND LEISURE

Stadiums
Overview ... 318
Spectator stands ... 319

Sports Facilities
Playing areas ... 320
Athletics ... 323
Tennis ... 327
Miniature golf ... 329
Golf courses ... 331
Water sport, marinas ... 333
Water sport, rowing and canoeing ... 339
Equestrian sport ... 341
Ski jumping ... 343
Ice rinks ... 344
Roller skating rinks ... 345
Speed roller skating, skateboarding ... 346
Cyclo-cross, BMX ... 347
Shooting ranges ... 348

Sports Halls
Dimensions ... 350
Layout, construction ... 352
Equipment ... 353
Stands ... 354
Examples ... 355
Judo ... 356
Wrestling ... 356
Weight-lifting ... 356
Boxing ... 356
Badminton ... 356
Squash ... 357
Table tennis ... 357
Billiards ... 357
Condition, fitness ... 358
Climbing halls ... 360
Bowling alleys ... 361

Swimming Pools
Indoor swimming pools ... 362
Outdoor pools ... 367
Indoor/outdoor pools ... 368
Private pools ... 371

Spa
Sauna/small sauna/wellness ... 372

Amusement Arcades
Amusement arcades ... 375

TRANSPORT

Roads
Street spaces ... 376
Types of road ... 377
Motorways ... 378
Traffic space ... 379
Inter-urban roads ... 380
Intersections ... 381
Footpaths and cycle ways ... 382
Bicycle traffic/storage ... 383

Traffic calming ... 385
Noise protection ... 386

Parking Facilities
Vehicles ... 387
Vehicles turning ... 389
Parking spaces ... 390
Multi-storey car parks ... 392
Ramps ... 393
Multi-storey car park regulations ... 394
Parking systems ... 395
Vehicles – trucks ... 397
Trucks – parking and turning ... 398
Service areas ... 399
Petrol stations ... 400
Car wash ... 402

Public Transport
Conditions, means of transport ... 403
Stops and stations ... 404
Traffic spaces ... 405
Bus stations ... 406

Railways
Tracks ... 408
Typical Continental European structure – gauges and clearances ... 410
UK structure – gauges and clearances ... 411
Freight Transport ... 413
Freight transport ... 413
Stations ... 414
Station buildings ... 415
Platforms ... 416
Platform furniture ... 417

Aviation
Basics ... 418
Airports ... 419
Runways ... 420
Terminals ... 421
Terminal and apron ... 422
Aeroplanes ... 423

EXTERNAL WORKS

Cemeteries
Morgue and crematorium ... 424
Graves, cemetery chapel ... 425
Cemeteries ... 426

Landscape Architecture
Design aspects and concepts ... 426

Earthworks
Soil ... 428

Garden Enclosures
Walls and fences ... 430

Pergola and Trellis
Pergolas ... 432
Trellises ... 433
Examples of plants ... 434

Paths, Paving, Steps
Design aspects ... 435

Drainage
Rainwater management ... 436

Vegetation
Plants ... 437
Plants and lawns ... 438

Biological Engineering
Supporting slopes and riverbanks ... 439

Greenhouses
Greenhouses ... 441

Ponds and Pools
Garden pond ... 442
Natural swimming pool ... 443
Water plants for natural swimming pool ... 444

External Works – Example
Federal Environment Agency ... 445

AGRICULTURE

FARMYARDS
Basics ... 446
Space requirements ... 447
Machinery ... 448
Fodder storage ... 449
Dung and drainage ... 450
Climate in animal housing ... 451

Animal Husbandry
Housing poultry ... 452
Keeping small animals ... 453
Sheep housing ... 454
Laying hens ... 455
Pig keeping ... 456
Dairy farming ... 457
Finishing beef cattle ... 458
Keeping horses ... 459

Supply and Disposal
Loading yards ... 461
Loading ramps, bridges, lifting platforms ... 462
Rubbish chute systems ... 463
Rubbish collection rooms ... 464
Emergency power rooms ... 465

BUILDING SERVICES

Renewable Energy
Overview ... 466
Solar energy ... 467
Bioenergy ... 468
Geothermal energy, heat pumps ... 469
CHP, block heating and power, fuel cells ... 470

Building Physics
Thermal insulation ... 471
Sound insulation ... 477
Room acoustics ... 482
Lightning protection ... 485

Daylight
Physical basics ... 488
Position of the sun ... 489
Insolation ... 490
Shadow ... 493
Radiation energy ... 494
Window lighting ... 495
Rooflighting ... 497
Quality criteria ... 498
Directing sunlight ... 499
Sun shading ... 500

Lighting
Artificial lighting ... 501
Lamps ... 502
Types of lighting ... 505
Lighting layout ... 506
Quality criteria ... 507
Illuminance ... 508

Fluorescent tubes 509
Workplace Guideline 'Artificial lighting' (excerpt) 510

Fire Protection
Basics 511
Classification 512
Fire compartment walls 513
Building components 514
Fire-resistant glazing 516
Fire-resistant door sets 517
Fire fighting installations 518
Smoke and heat extractor systems 519
Sprinkler systems 520
Other extinguishing systems 521

Domestic Installation
Drainage 522
Ventilation 528
Heating 532
Small sewage treatment plants 536

Chimneys and Ventilation Shafts
Chimneys 537
Open fireplaces 538
Ventilation shafts 539

References 540

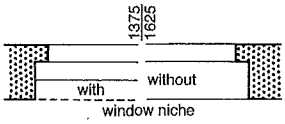
BS and DIN Standards 548

Conversion of Units
Weights and measures 555
Conversion tables 560

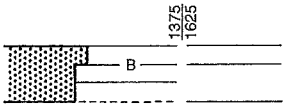
INDEX 575

DRAWINGS
Paper formats
Technical drawings
Layout of drawings
Construction drawings
Construction drawing symbols
Water supply and drainage symbols
Electrical installation symbols
Security installation symbols
Gas installation symbols
Drawing by hand
Computer-aided drawing

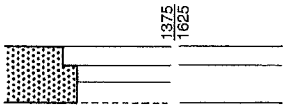
Windows set in reveals, scale 1:100



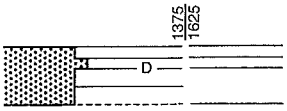
❶ Single window opening inward gains space and offers a place for the radiator



❷ Box window (B) opening inward, double window, combined window

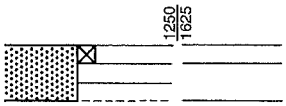


❸ Single window opening outward



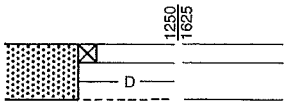
❹ Double window (D) opening outward

Sash window, scale 1:100

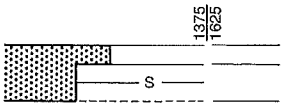


❺ Single window

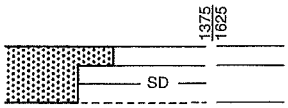
Sliding window, scale 1:100



❻ Double window (D), box window, combined window

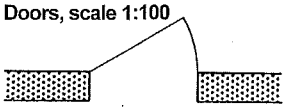


❼ Single window (S)

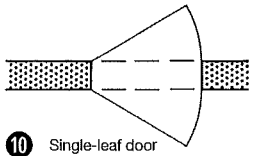


❽ Double window (SD)

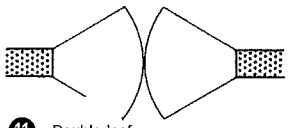
Doors, scale 1:100



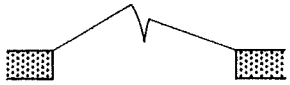
❾ Single-leaf door without lintel



❿ Single-leaf door pair, with lintel



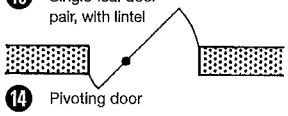
⓫ Double-leaf swing door



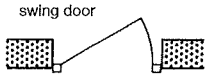
⓬ Double-leaf door



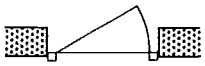
⓭ Pivoting door



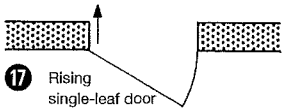
⓮ Pivoting door



⓯ Without threshold



⓰ Threshold one side



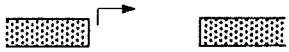
⓱ Rising single-leaf door



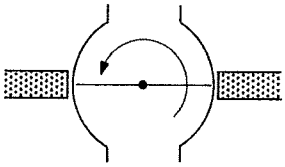
⓲ Sliding door



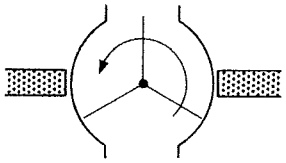
⓳ Double sliding door



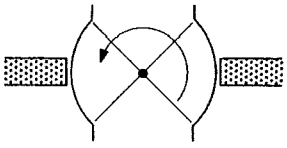
⓴ Sliding door with lifting mechanism



㉑ Two-leaf revolving door



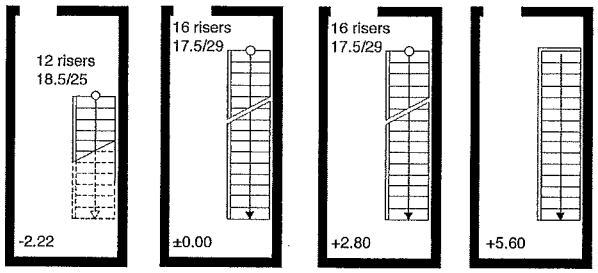
㉒ Three-leaf revolving door



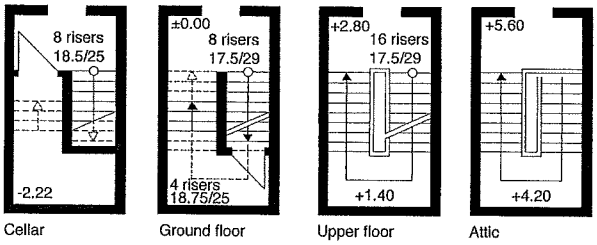
㉓ Four-leaf revolving door



㉔ Folding partition



㉕ Stairs with one flight

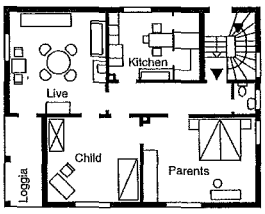


㉖ Stairs with two flights

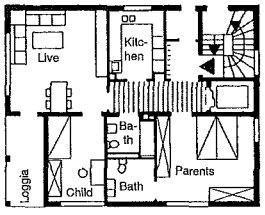
When drawing **windows,** the left side is always shown with wall niche and the right side without → ❶ – ❽.

Revolving doors replace wind lobbies → ㉑ – ㉓ and offer an opening without draughts. Because revolving doors can cope with relatively little through traffic, the door leaves can be folded at peak times and pushed to the side.

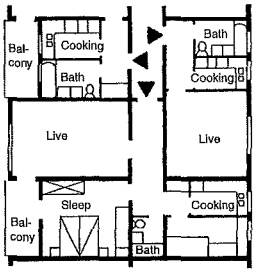
The horizontal section through the stairwell on each floor's plan is shown at about ⅓ storey height or 1 m above floor level. The steps should be continuously numbered upwards and downwards starting from ± 0.000. The number of steps below ± are preceded by a minus sign –. The numbers begin on the first step and exit on the landing. The centre-line starts at the first step with a circle and ends on arriving with an arrow (also in the cellar).



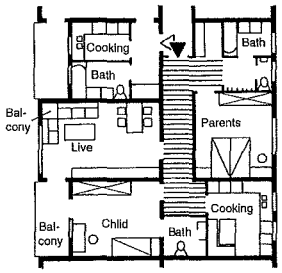
❶ Flat in two-family house before conversion → ❷



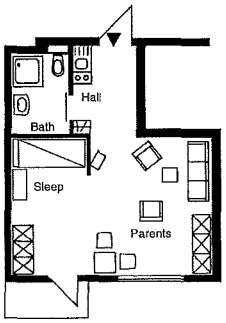
❷ Flat in two-family house after conversion for serious disability



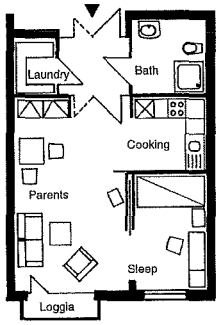
❸ 2½ living room and 1 bedroom flat before conversion → ❹



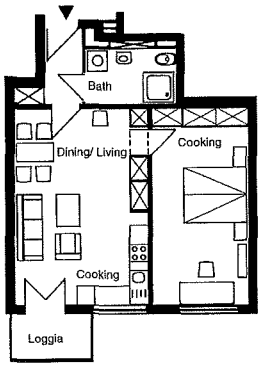
❹ One living room and two bedroom flat after conversion (for a visually impaired child)



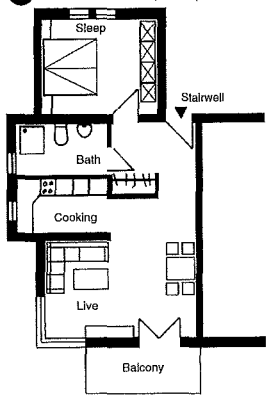
❺ One-room flat (40 m²)



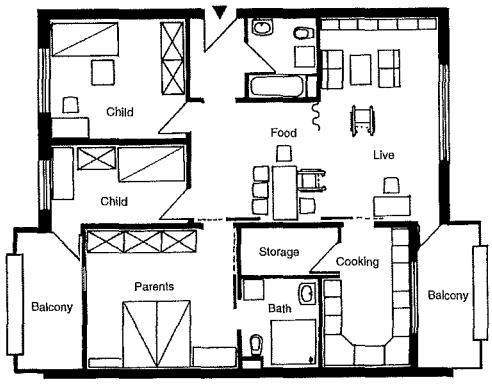
❻ One-room flat (45 m²)



❼ Two-room flat (54 m²)



❽ Flat (60 m²)



❿ Four-room flat (110 m²)

Accessible building

(§ 50 of MBO – Model Building Regulations – applied at state level)

(1) In buildings with more than two flats, the flats on one floor must be accessible. In these flats, the living rooms and bedrooms, one toilet, one bathroom and the kitchen or kitchenette must be accessible with a wheelchair.

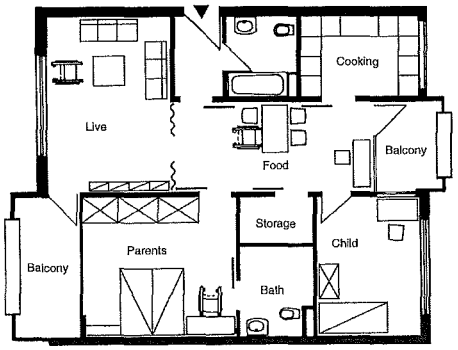
(2) Buildings which are publicly accessible, must in their parts serving the general public be capable of being accessed and used, according to their purpose, by disabled people, old people and people with small children, without outside help. This requirement applies notably to cultural, educational, sport, leisure and health facilities, offices, administration buildings and courts, sales and catering establishments, parking, garages and toilets.

(3) Buildings, according to (2), must be accessible through an entrance with a clear opening width of at least 0.90 m without steps. An adequate movement area must be available in front of doors. Ramps may not have a slope of more than 6%, must be at least 1.20 m wide and have a fixed handrail with a safe grip on both sides. A landing is to be provided at the start and end of the ramp and also an intermediate landing every 6 m. The landings must have a length of at least 1.50 m. Stairs must have handrails on both sides, which are to be continued past landings and window openings and past the last steps. The stairs must have solid risers. Corridors and entrance halls must be at least 1.50 m wide. One toilet must also be suitable and accessible for wheelchair users; this is to be indicated by a sign.

(4) Sections 1–3 do not apply if the installations can only be fulfilled with unreasonable expense on account of difficult terrain conditions, the installation of an otherwise unnecessary lift, unsuitable existing buildings or the safety of disabled or old people.

	1 person	2 people	3 people
living room	20.0	20.0	22.0
dining area	6.0	6.0	10.0
bedroom	16.0	24.0	16.0
child (1 bed)	–	–	14.0
bathroom	6.0	7.0	7.0
kitchen	8.0	9.0	9.0
corridor	5.0	6.0	6.0
storage room	1.0	1.0	1.5
storage (E-wheelchair)	6.0	6.0	6.0
spare room (washing machine)	1.0	1.0	1.0
living area	**69.0**	**80.0**	**98.5**

❾ Guideline sizes for flats with one wheelchair user – living area in m² [determination of requirements www.nullbarriere.de]



⓫ Three-room flat (95 m²)

DIMENSIONAL BASICS AND RELATION-SHIPS
Man as measure and purpose
The universal standard
Body measurements and space requirements
Geometrical relationships
Dimensions in building

Throughout history human beings have created things to be of service to them, using measurements relating to their bodies. Until relatively recent times people's limbs were the basis for all the **units of measurement.** Even today we can still have a better idea of the size of an object if it is compared to humans or their limbs: it was so many men high, so many ells (arm lengths) long, so many feet wider or so many heads bigger. These are expressions that we are born with: it could be said that their sizes are in our nature. But the introduction of the **metre** brought all that to an end.

We should therefore attempt to achieve the most precise and vivid possible idea of this unit. Building clients do the same when they measure out the rooms of their properties in order to envisage the dimensions shown on the drawings. Anyone who intends to learn how to build should start by visualising the size of rooms and objects as clearly as possible, and constantly practise, so that every line they draw and every stated dimension of yet to be designed furniture, rooms or buildings can appear as an image before their eyes.

We do, however, immediately have an accurate idea of the scale of an object when we see a **person** beside it, whether in the flesh or as an illustration. It is a poor reflection on our times that our trade and professional journals only too often depict rooms or buildings without any people in them. Such pictures can often create a false impression of the scale of a building and it is often astonishing how different they look in reality – mostly much smaller. This contributes to the frequent lack of cohesive relationships between buildings, because their designers have worked to various arbitrary scales and not to the only proper scale, human beings.

If this is to be changed, then **architects and designers** must be shown where these haphazard dimensions, mostly accepted without thought, originated. They must understand the relationships of the size of the limbs of a healthy human being and how much space a person occupies in various postures and in movement. They must also be familiar with the dimensions of the **appliances**, clothing etc. which people encounter every day, in order to be able to determine the appropriate sizes for containers and furniture. They must know how much **space** a person needs between furniture in the kitchen, dining room, libraries etc. in order to undertake the necessary reaching and working among these fittings in comfort without squandering space. They must know how **furniture** should be placed so that people can fulfil their tasks or relax in the home, office or workshop. And, finally, the architect and designer need to know the minimum practical dimensions of spaces in which people move around on a daily basis, like trains, trams, vehicles etc. These typically very restricted minimum spaces give the designer fixed impressions, which are then used, even if unintentionally, to derive dimensions of other spaces.

The human being, however, is not just a living creature that needs space. The **emotional response** is no less important. The way a room is dimensioned, divided, painted, lit, entered and furnished has great significance for the impression it makes. Starting from all these considerations and insights, I set out in 1926 to collect, in an organised way, the experience gained from a wide variety of professional practice and teaching.

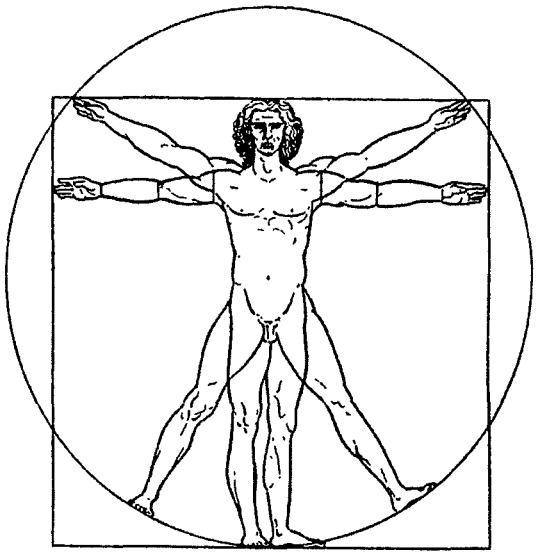
The present data book was developed from this work, starting from the human being and providing the framework for assessing the dimensions of buildings and their constituent parts. This involved, for the first time, the investigation, development and comparison of many fundamental questions.

Current technical options have been included here to the greatest possible extent. Account is taken of common **standards**. Description is often reduced to the absolute minimum and supplemented or even replaced with illustrations wherever feasible. This should provide the creative architect or designer, in methodically ordered, brief and coherent form, the necessary information which would otherwise have to be laboriously extracted from countless books or researched circuitously by surveying existing buildings. Great value has been placed on the restriction of the content to a digest of the fundamental data and experience, with the inclusion of completed buildings only where they seemed necessary as general examples.

By and large, of course, each building commission is different and (apart, of course, from adherence to relevant standards) should be studied, approached and designed anew by the architect. Completed projects can much too easily tempt us to imitate, or at least establish conventions, which the architect entrusted with a similar task can often escape only with difficulty. If, however, as is intended here, creative architects are given only the tools, then this compels independent thinking so that they weave all the components of the current commission into their own imaginative and unified construction.

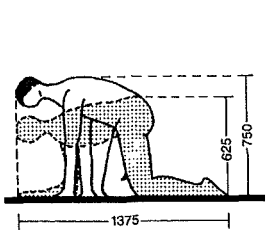
Finally, the tools presented here have not been collected more or less randomly from some journal or other, but systematically sought out in the literature as the data required for each building task. They have been checked against well-known examples of similar buildings and, where necessary, data has also been acquired through models and experiments. This was always with the intention of saving the practising architect or designer the effort of these basic investigations, so that sufficient time and leisure can be devoted to the important creative aspects of the commission.

Ernst Neufert

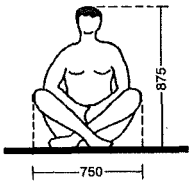


1 Leonardo da Vinci: Rules of Proportion

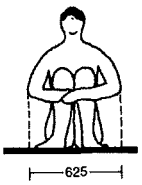
DIMENSIONAL BASICS AND RELATIONSHIPS
Man as measure and purpose
The universal standard
Body measurements and space requirements
Geometrical relationships
Dimensions in building



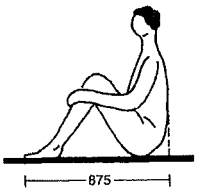
1 Crawling



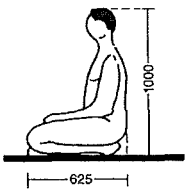
2 Sitting cross-legged



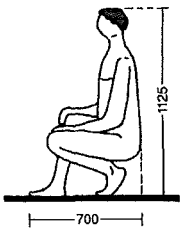
3 Sitting (from the front)



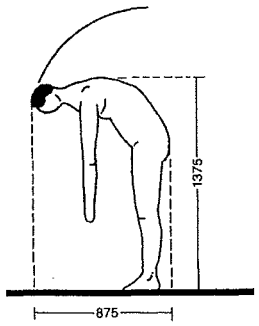
4 Sitting (from the side)



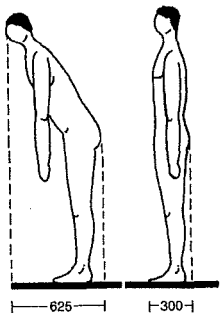
5 Kneeling



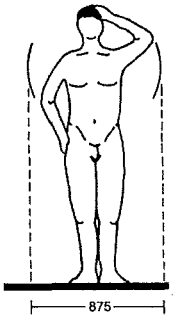
6 Squatting



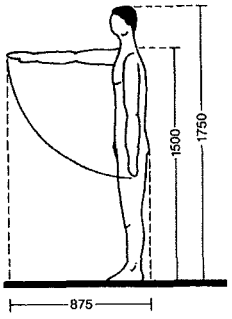
7 Bending over



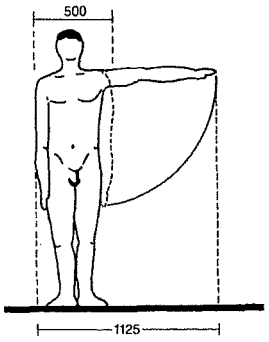
8 Standing leaning forward, standing



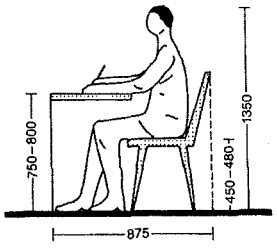
9 In movement



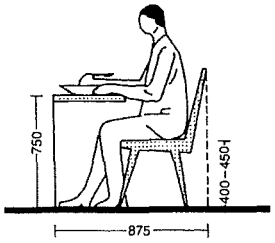
10 Outstretched arm (forwards)



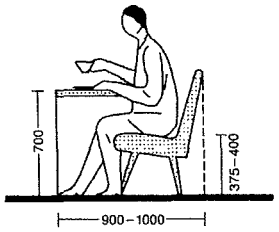
11 Outstretched arm (sideways)



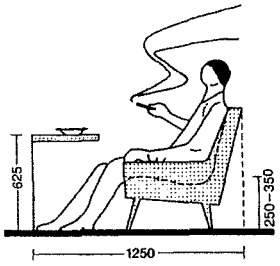
12 Dimensions: at the desk



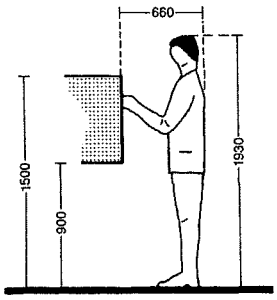
13 Dimensions: at the dining table



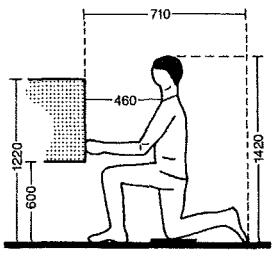
14 Dimensions: in a small easy chair



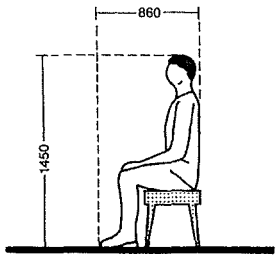
15 Dimensions: in an armchair



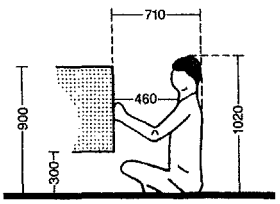
16 Working while standing



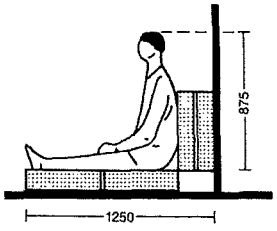
17 Kneeling



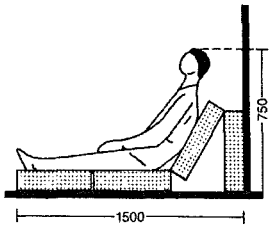
18 Sitting on a chair



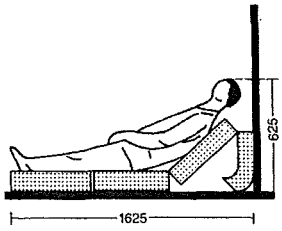
19 Sitting on the floor



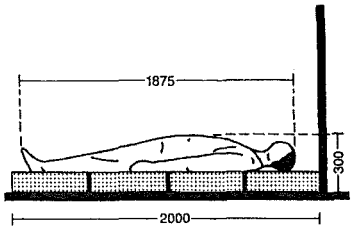
20 Sitting on a mattress



21 Leaning against sloping backrest



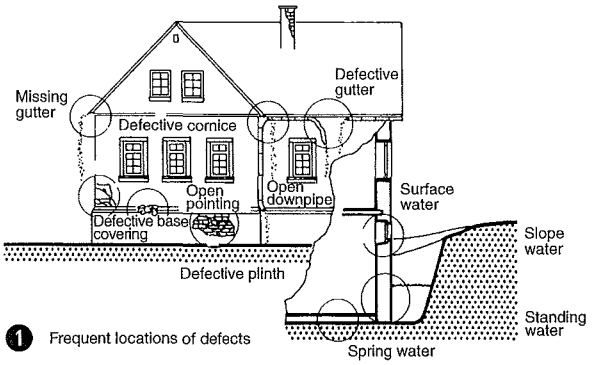
22 Lying with raised back



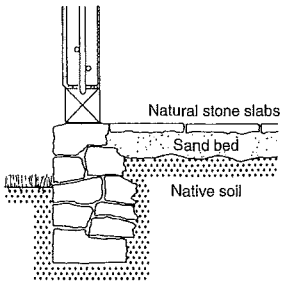
23 Lying

Most building defects are caused by damp. Rising damp from the ground can be caused by missing or defective damp proofing over the foundations or cellar, missing or silted drainage or defective rainwater goods, resulting in surface water at the transition area between ground and wall.

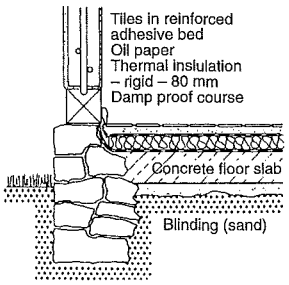
When a repair is undertaken, it also necessary to investigate and remedy the cause of the moisture penetration. Missing or damaged horizontal damp courses are laborious to replace, and the work needs to be carried out very carefully because the capillary transport of moisture must be interrupted. Building elements, which are impossible to waterproof, or only at excessive expense, can be coated using special plaster systems, which enable the damp to evaporate. The efflorescence of mineral salts resulting from evaporation can be absorbed for a long time, but the durability of such remedial plasters is still considerably shorter than plaster on a dry substrate.



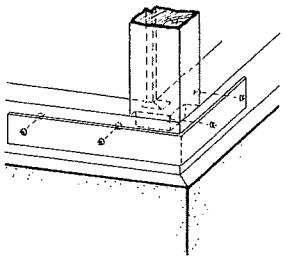
1 Frequent locations of defects



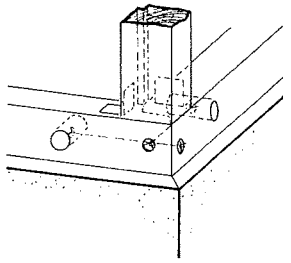
2 Old natural stone flooring of a ground floor without cellar



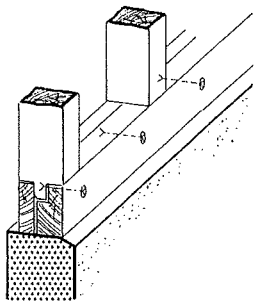
3 Renewal of the floor with thermal insulation and damp-proof layer on a sub-concrete of lime mortar



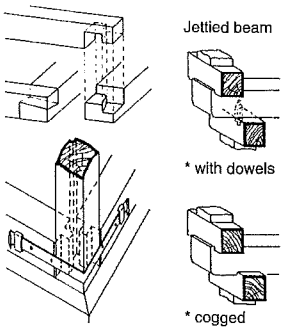
4 Corner reinforcement with a metal angle



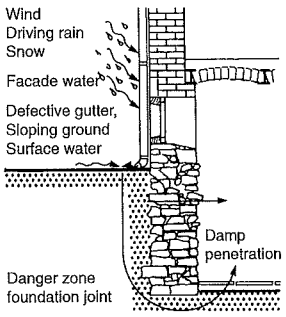
5 Corner of sill beam newly anchored with coach bolts



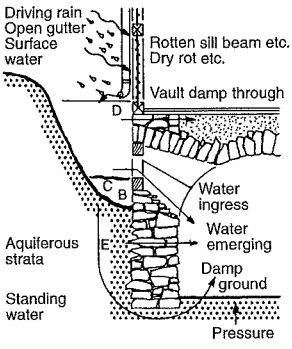
6 Replacement of sill beam in two stages



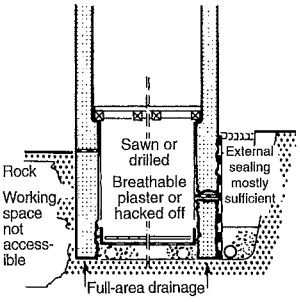
7 Possible corner joints for timber frame sill beams (tension and compressive loading)



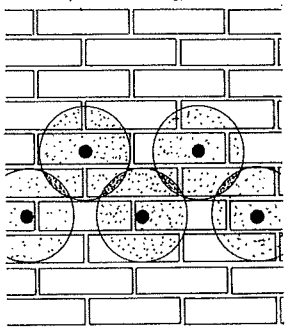
8 Main sources of damage from water without pressure



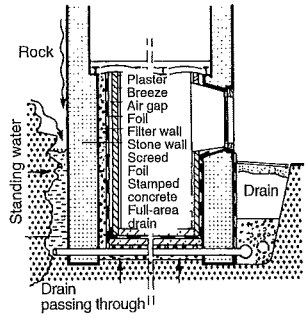
9 Main sources of damage from water under pressure



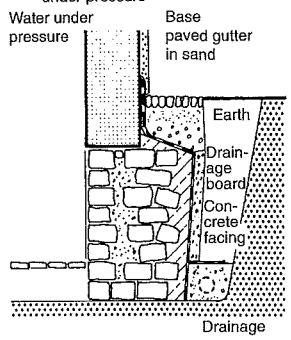
10 Supplementary horizontal isolation and waterproofing of a damp cellar



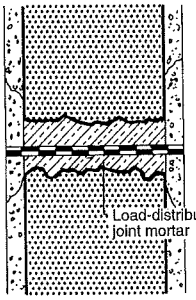
11 Injected damp-proofing



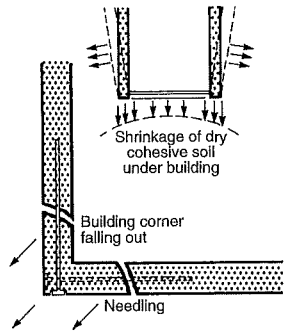
12 Internal waterproofing of partially inaccessible external walls



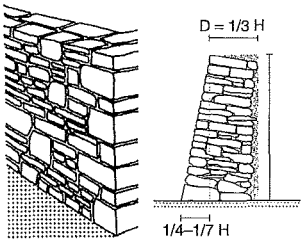
13 Repair of foundations built in contact with the earth



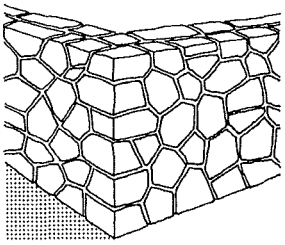
14 Supplementary insertion of horizontal waterproofing (wall separation)



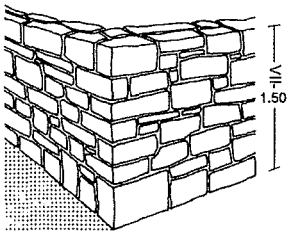
15 Needling of a subsiding house corner



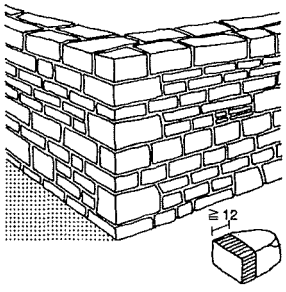
❶ Dry stone walling / section



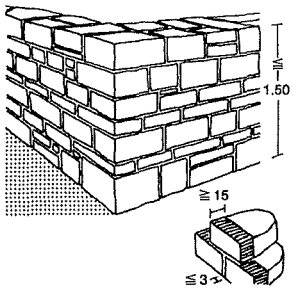
❷ Cyclopean masonry of volcanic stone



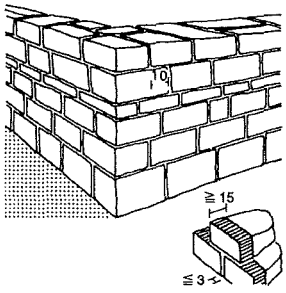
❸ Rubble masonry



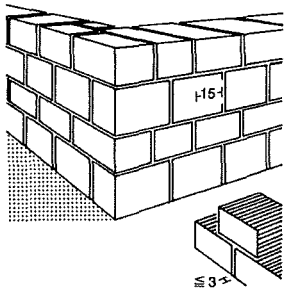
❹ Rubble masonry squared with a hammer into courses



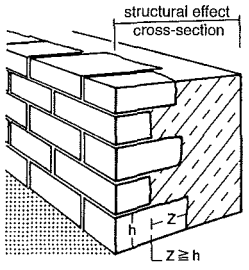
❺ Irregularly coursed masonry



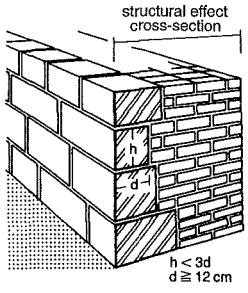
❻ Regularly coursed masonry



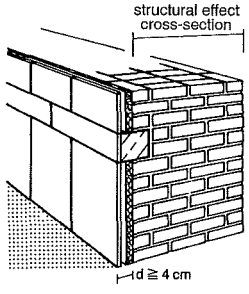
❼ Ashlar masonry



❽ Composite masonry



❾ Composite masonry showing the structurally effective section



❿ Stone cladding without structural contribution

Natural stone walling can be categorised into **rubble, cyclopean, coursed, ashlar and composite**.

Stone, which has a natural plane of cleavage, should be split and laid according to the cleavage, e.g. → ❶, ❸, ❹, which looks better and is also structurally sounder because the loading is then mostly at right angles to the natural bedding.

The size of the individual blocks is of great importance. The block length should not be more than four to five times the block height and should not be less than the height (the stones should be bonded well on all sides). Pure natural stone masonry must be bonded in the entire cross-section in accordance with good trade practice.

There should never be more than three joints meeting at the front or rear surfaces of a block and no vertical joint should pass through more than two courses. For structural reasons, a course should be brought flat and level every ≦1.5 m (spacing of scaffold platforms).

Header and stretcher courses must alternate, or there must be at least one header for every two stretchers in each course. The depth (into the wall) of the headers must be at least 1½ times the course height but at least 30 cm.

The depth (into the wall) of the stretchers must be about equal to the course height. The vertical joints must be covered by ≧10 cm in coursed masonry and ≧15 cm in ashlar masonry → ❺ + ❼, and the largest blocks should be laid at the **corners** → ❶ – ❻. **Face surfaces** should subsequently be fully pointed, first scratching out a depth equal to the joint width. The joints should be about 3 cm thick according to roughness and method of working. Lime or lime-cement mortar should be used, as cement can discolour certain types of stone. In **composite masonry**, the worked stone facing can be integrated into the load-bearing cross-section → ❾. Non-load-bearing **stone cladding** of 2.5–5 cm thickness is fixed to the backing wall with anchors → ❿.

Stone type	Compressive strength (N/mm^2)
limestone, travertine, volcanic tuff	20
weak sandstone (with clay binder) and similar	30
dense (strong) limestone and dolomite (incl. marble), basalt lava and similar	50
quartzitic sandstone (with siliceous binder), greywacke and similar	80
granite, syenite, diorite, quartz porphyry, black porphyry, diabase and similar	120

⓫ Minimum compressive strengths of building stone

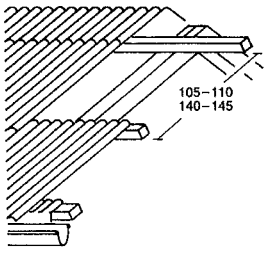
Grade	Stone strength βst (N/mm^2)	Basic values σ_0[1] for mortar group I (MN/m^2)	II (MN/m^2)	IIa (MN/m^2)	III (MN/m^2)
N1	≧20	0.2	0.5	0.8	1.2
	≧50	0.3	0.6	0.9	1.4
N2	≧20	0.4	0.9	1.4	1.8
	≧50	0.6	1.1	1.6	2.0
N3	≧20	0.5	1.5	2.0	2.5
	≧50	0.7	2.0	2.5	3.5
	≧100	1.0	2.5	3.0	4.0
N4	≧20	1.2	2.0	2.5	3.0
	≧50	2.0	3.5	4.0	5.0
	≧100	3.0	4.5	5.5	7.0

[1] If joints are more than 40 mm thick, then the basic values σ_0 are to be reduced by 20%.

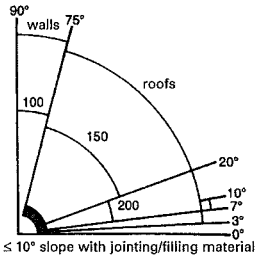
⓬ Basic values σ_0 of the permissible compressive stresses for natural stone masonry with normal mortar

Grade	Basic category	Joint height / block length	Slope of bed joint – tan α	Transfer factor η
N1	rubble masonry	≦0.25	≦0.30	≧0.50
N3	masonry hammered into courses	≦0.20	≦0.15	≧0.65
N3	coursed masonry	≦0.13	≦0.10	≧0.75
N4	ashlar masonry	≦0.07	≦0.05	≧0.85

⓭ Guideline values for the grading of natural stone masonry

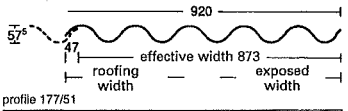


❶ Corrugated cement fibre roofing with shaped pieces for eaves and ridge, load 0.20 kN/m²



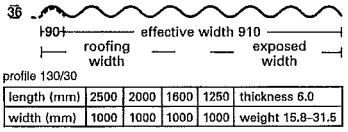
≤ 10° slope with jointing/filling material

❷ Minimum roof pitches → ❶ and lap lengths



profile 177/51

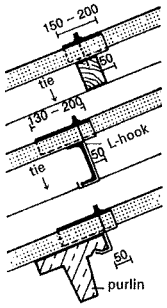
length (mm)	2500	2000	1600	1250	thickness 6.5
width (mm)	920	920	920	920	weight 16–32 kg



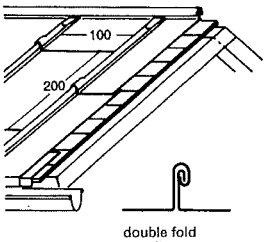
profile 130/30

length (mm)	2500	2000	1600	1250	thickness 6.0
width (mm)	1000	1000	1000	1000	weight 15.8–31.5

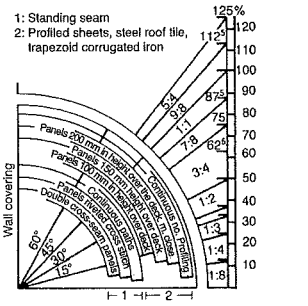
❸ Corrugated cement fibre roofing sheets



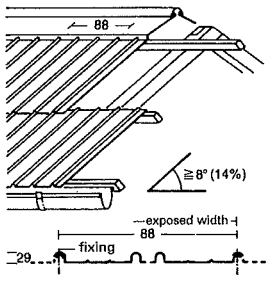
❹ Methods of fixing



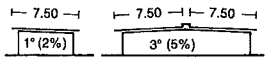
❺ Metal sheet roof with welted joint construction, load 0.25 KN/m²



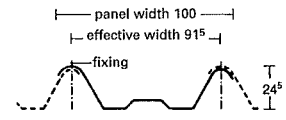
❻ Minimum roof pitch for roof covering of galvanised steel sheet



❼ Steel pantile roofing, load 0.15 KN/m²

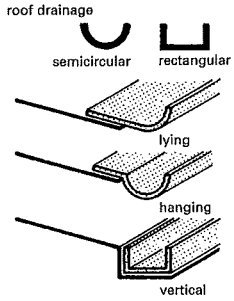


length (mm)	9000	7500	4000	thickness 8.0
width (mm)	1000	1000	1000	weight 19 kg/m



❽ Large elements for roof and wall (Canaleta)

roof drainage



❾ Possible shapes and locations of gutter

Zinc sheet DIN 9721
at least 0.7 mm (Zn)
Gutter brackets: zinc-coated strip steel (St 2)
Galvanised strip steel DIN 1541 leaded (St 2)
Gutter bracket: galvanised strip steel (St 2)
Semi-hard copper sheet DIN 1787 (Cu)
Gutter brackets: flat copper (Cu)
Aluminum sheet cut in half DIN 1725 (Al)
Gutter brackets: galvanised strip steel (St 2)

Specification:
(example: semi-circular gutter 333 Zn 0.75 mm; with gutter bracket 333 St Zn)

❿ Materials

Roof coverings (continued)

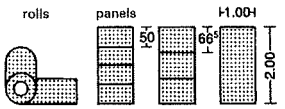
Cement fibre roof → ❶ – ❷ composed of corrugated sheets with purlin spacing of 70–145 cm for 1.6 m sheets, of 1.15 and 1.175 m for 2.50 m sheets; lapped 150 or 200 mm.

Sheet metal roof → ❺ – ❼ of zinc, titanium-zinc, copper, aluminium, galvanised steel sheet etc. Many special shapes available for ridge, eaves, edge etc. Copper sheeting is in commercially produced sizes → ⓬. Copper has the highest elongation at break of any metal sheeting and is therefore suitable for embossing, pressing, stretching and compressing. The typical patina of copper roofing is very popular. Combination with aluminium, titanium-zinc and galvanised steel should be avoided, but with lead and high-grade steel there is no problem. Copper roofs are impermeable to water vapour and thus particularly suitable for cold roofs → p. 90.

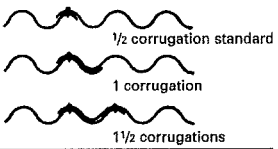
	kN/m²
'beaver-tail' tiles and 'beaver-tail' concrete tiles	
with underlay incl. underlay parts	0.60
clay tiles, single or double lap	0.80
extruded interlocking clay tiles	0.60
interlocking tiles, reform pantiles, interlocking pantiles, flat tiles	0.55
interlocking tiles	0.55
Spanish tiles, concave tiles	0.50
pantiles	0.50
large-format pantiles (up to 10 per m²)	0.50
Spanish tiles without mortaring, 0.70 with mortaring	0.90
metal sheeting, aluminium roof (aluminium 0.7 mm thick) incl. boarding	0.25
copper roof with double seams (copper sheet 0.6 mm thick) incl. boarding	0.30
double standing seam roof of galvanised seamed sheeting (0.63 mm thick) including underlay and boarding	0.30
German slate roof on boarding incl. felt underlay and boarding	
large format (360 mm × 280 mm)	0.50
small format (about 200 mm × 150 mm)	0.45
English slate roof incl. battens	
on battens with double lap	0.45
on boarding and underlay incl. boarding	0.55
Old German slate roof on underlay and boarding	0.50
with double lap	0.60
steel pantile roof (galvanised steel sheets)	
on battens incl. battens	0.15
on boarding incl. underlay and boarding	0.30
corrugated steel roof (galvanised steel sheets) incl. fixings	0.25
zinc roof with cover strips of zinc sheet incl. boarding	0.30

⓫ Loads per 1 m² pitched roof surface (without rafters, purlins or trusses, but including battens). If mortar-pointed, add 0.1 kN/m².

supplied form	rolls	panels
length (m)	30–40	2.0
max. width (m)	0.6 (0.66)	1.0
thickness (mm)	0.1–2.0	0.2–2.0
specific wt (kg/dm³)	8.93	8.93



⓬ Form and dimensions of rolled copper material for strip and sheet roofing



roof depth eaves/ridge	profile ht 18–25 mm	26–50 mm
up to 6 m	10° (17.4%)	5° (8.7%)
6–10 m	13° (22.5%)	8° (13.9%)
10–15 m	15° (25.9%)	10° (17.4%)
over 15 m	17° (29.2%)	12° (20.8%)

8–10°	200 mm with sealing of overlap
10–15°	150 mm without sealing of overlap
over 15°	100 mm without sealing of overlap

⓭ Corrugated sheet metal roofing, minimum roof pitch, side laps

Roof area to be drained with semi-circular gutters (m²)	Guideline size of gutters (mm Ø)	Cut lengths for metal gutters (mm)
up to 25	70	200
25–40	80	200 (10-part)
40–60	90	250 (8-part)
60–90	125	285 (7-part)
90–125	150	333 (6-part)
125–175	400 (5-part)	400 (5-part)
175–275	200	500 (4-part)

Gutters should generally be installed on a slope as greater flow speed helps prevent blocking, corrosion and freezing. Guttering supports normally consist of galvanised steel strips, width 20–50 mm and thickness 4–6 mm.

⓮ Guideline sizes for gutters

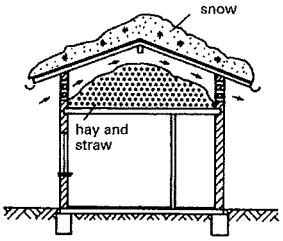
Roof area to be drained with round downpipes (m²)	Guideline size of downpipe (mm Ø)	Cut lengths for metal pipes (mm)
up to 20	50	167 (12-part)
20–50	60	200 (10-part)
50–90	70	250 (8-part)
60–100	80	285 (7-part)
90–120	100	333 (6-part)
100–180	125	400 (5-part)
180–250	150	500 (4-part)
250–375	175	
325–500	200	

Fixing with pipe clips (corrosion-protected), whose inner diameter is that of the downpipe. Minimum distance of downpipe from the wall 20 mm. Pipe clip spacing 2 m.

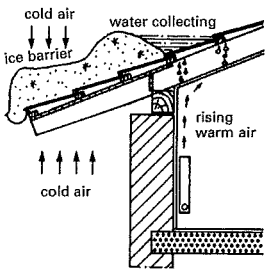
⓯ Guideline sizes for downpipes

ROOFS

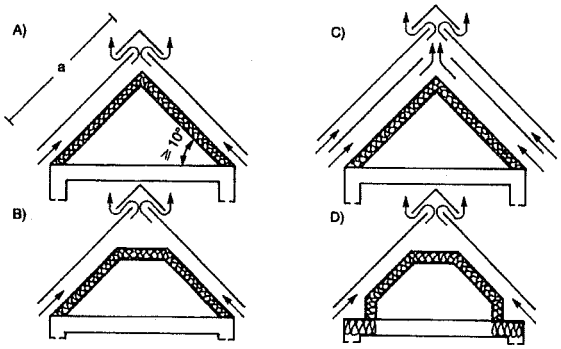
Pitched Roofs



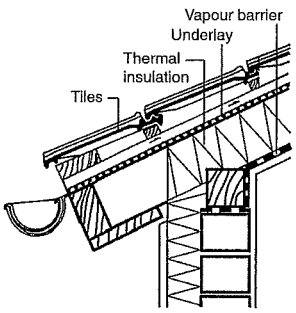
❶ Cross-section through an Alpine farmhouse with hay loft



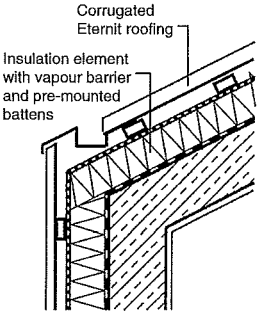
❷ Ice blockage problem



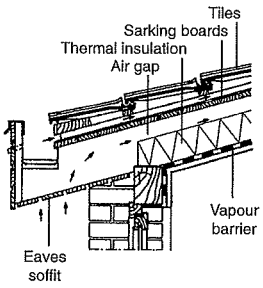
❸ Arrangement of thermal insulation in roof spaces (cold roofs)



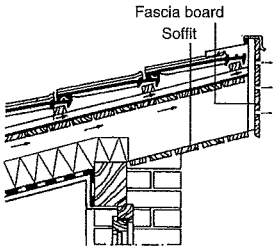
❹ Normal warm roof



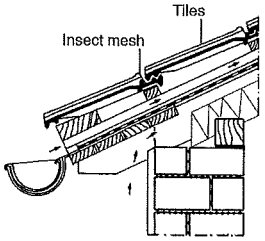
❺ Concrete roof with warm roof construction



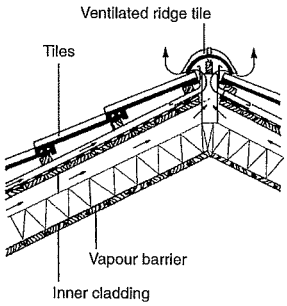
❻ Cold roof: eaves detail, eaves soffit with ventilation slots



❼ Cold roof (monopitch): ridge detail, fascia board with ventilation slots



❽ Cold roof: eaves detail with exposed rafters



❾ Cold roof: ridge detail

Roof spaces

Spaces under pitched roofs were formerly used as naturally ventilated 'hay lofts' for the storage of the harvest. The rooms below were protected from cold by the stored produce → ❶. Today, roof spaces are converted into habitable rooms. The roof construction must comply with additional building physics requirements.

Building methods

Thermally insulated roofs can be divided into **ventilated** and **non-ventilated** construction. In addition to the ventilation space between roof covering and underlay (or lower layer of roof), which is required in both cases, ventilated roof construction has an additional ventilation gap between underlay and thermal insulation, to remove spray and condensate.

Ventilated roofs require additional rafter depth and work properly only with a correctly installed vapour barrier and functioning roof ventilation. Therefore the building industry commonly prefers **unventilated roof construction.**

Standard build-up of layers

Roof coverings, battens → pp. 88–89

Underlay of plastic mesh-reinforced foil or vapour-permeable plastic sheeting serves to carry away any spray water or snow penetrating under the roof covering.

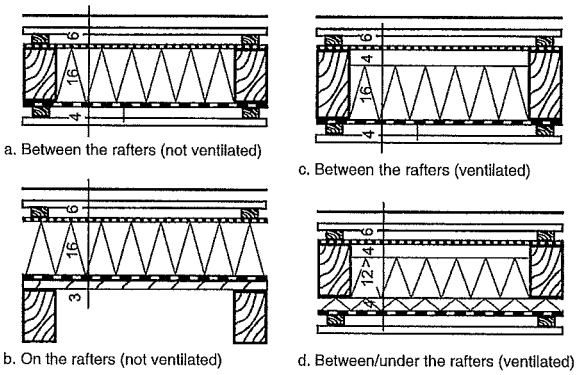
Roof boarding of tongue and groove boards with applied waterproofing (e.g. welded bitumen sheeting) is installed instead of underlay in conditions of severe exposure.

The **air gap** in ventilated roof construction serves as an additional ventilation layer (e.g. to remove condensation). The necessary ventilation cross-sections depend on the roof pitch.

Thermal insulation is generally in the form of mineral wool roll material and is installed between and under the rafters or as prefabricated insulation elements, sometimes with interlocking, vapour barrier on the room side and battens fixed to the rafters → ❿.

The **vapour barrier** is under the thermal insulation to prevent condensation inside the roof construction. When the vapour barrier is installed, it is important that all air flow between interior and roof construction is prevented. Any penetration points, laps and junctions with building elements must be carefully sealed.

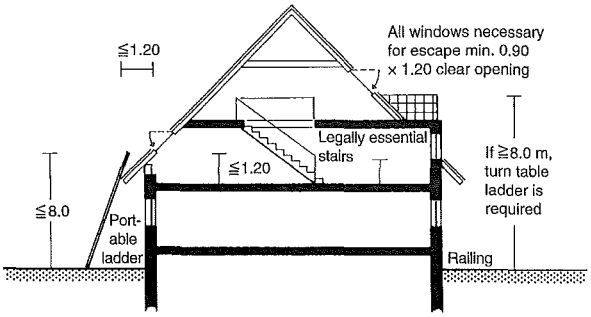
Inner cladding is normally plasterboard on support construction (pay attention to the possibility of cracks!).



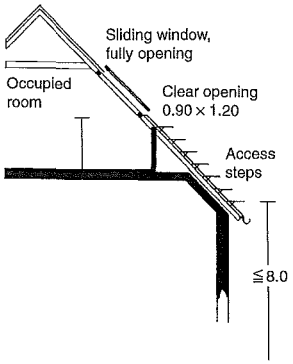
❿ Location of thermal insulation for pitched roofs converted for storage

Ladder access points must be located so that those in danger can attract the attention of people on public roads. Emergency ladders are items of building equipment which can be used for the rescue of occupants → ❶ – ❹ + ⓭. Access ladders, also described as vertical fixed ladders, are required for climbing onto roofs, chimneys, silos, containers, tanks, machines, plant etc.
For buildings over 5 m high, access ladders are required to have back protection. Each ladder run has a maximum climbing height of 10 m → ⓬ – ⓭. Hoop diameter 0.70 m.

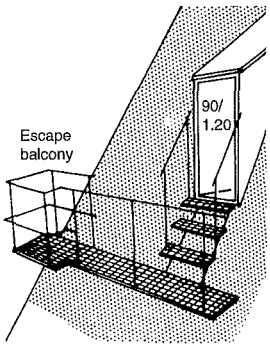
BS 4211
BS 5395
ASTM F21755
DIN 14094
DIN 18065
DIN 18799
DIN 24532



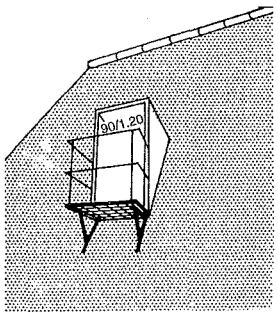
❶ Escape routes



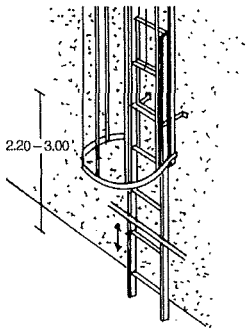
❷ Roof window as escape route



❸ Escape route with external platform

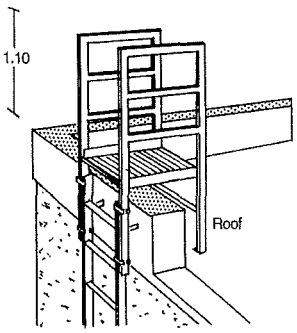


❹ Escape balcony/platform

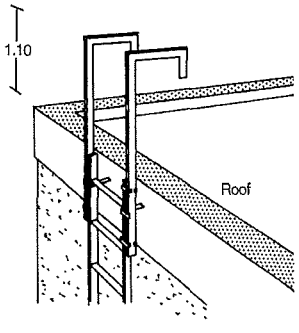


❺ Retractable access

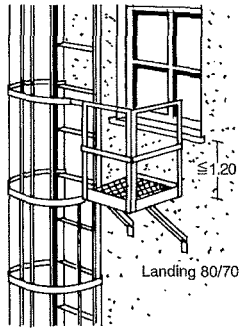
Dimensions → ❾		
Building height (m) from/to	Back protection (bp)	Pairs of wall fixings
3.0 – 4.0	–	3
4.0 – 5.0	–	3
5.0 – 6.0	BP	4
6.0 – 7.0	BP	4
7.0 – 8.0	BP	5
8.0 – 9.0	BP	5
9.0 – 10.0	BP	6
stepped construction → ❿ + ⓬		
10.0–11.0	BP	8
jumps of 1 m each up to		
19.0–20.0	BP	13



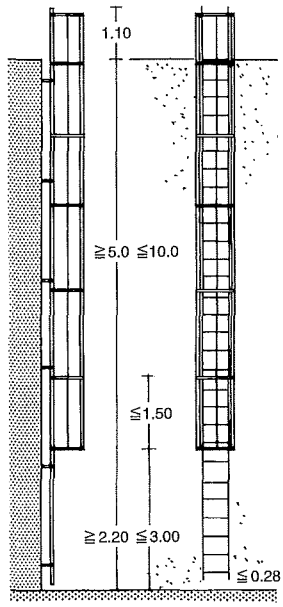
❻ Escape with gangway



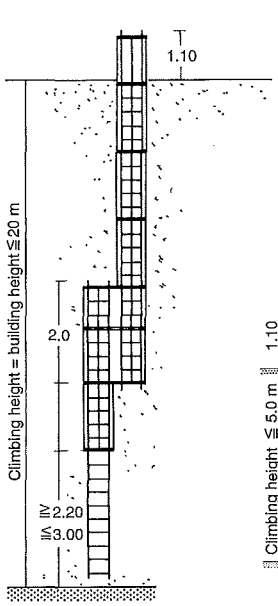
❼ Escape ladder extension



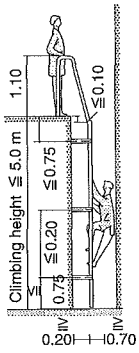
❽ Platform with handrail



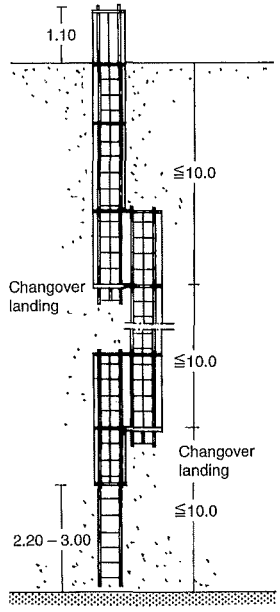
❾ Single-run access ladder



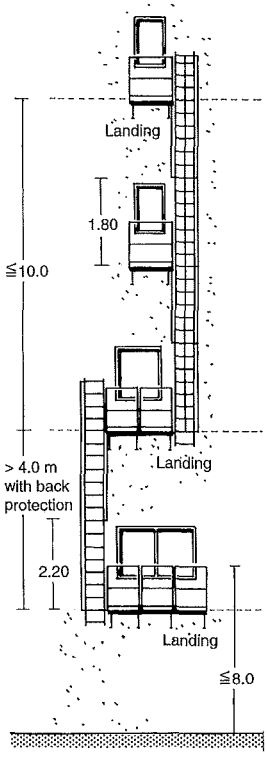
❿ Stepped access ladder



⓫ Fixed access ladder



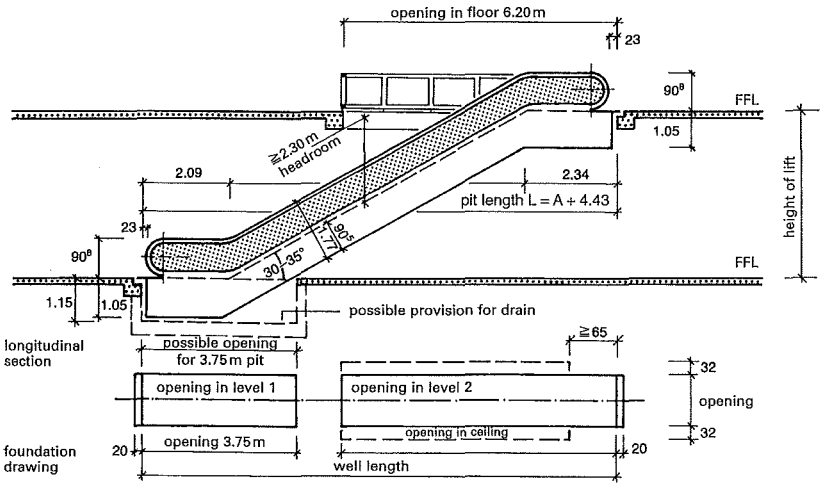
⓬ Access ladder with transfer platforms



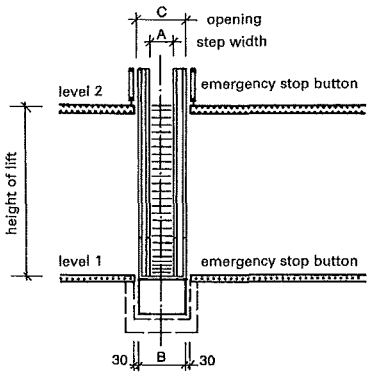
⓭ Emergency ladder

ESCALATORS

For Shops and Offices



❶ Section through escalator / foundation plan



❷ Width of steps

transportation capacity

$$Q = 3600 \times \frac{G_p \times v}{t} \times f \text{ (people/h)}$$

where
G_p = people per step (1, 1.5, 2)
v = conveyor speed (m/s)
t = tread (m)
f = 0.5–0.8 escalator utilisation factor

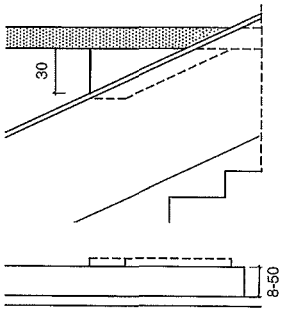
❸ General calculation formula for transport capacity

step width	800	1000
A	80–820	1005–1020
B	1320–1420	1570–1620
C	1480	1680
capacity/h	7000–8000 people	8000–10000 people

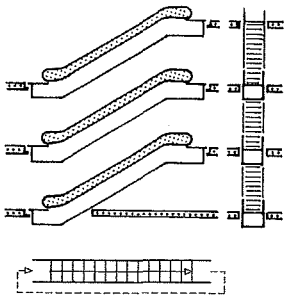
❹ Dimensions and capacities of escalators with 30° and 35° (27°; 18°) pitch. Step width → ❷

speed	travel time for one person	with a width sufficient for	
		1 person	2 people next to each other
0.5 m/sec	~18 sec	4000	8000
0.65 m/sec	~14 sec	5000	1000
		people/h transported	

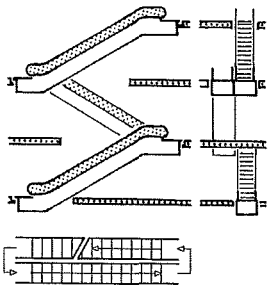
❺ Capacity data



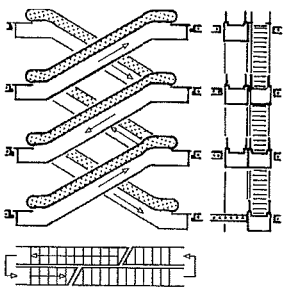
❻ Side guard detail



❼ Single flights parallel



❽ Single flights end-to-end



❾ Double flights crossing

In the UK, construction and operation of escalators is regulated by BS EN 115: 'Safety rules for the construction and installation of escalators and passenger conveyors'. In Germany, construction and operation of escalators follow the 'Guidelines for escalators and moving walkways', ZH1/484, issued by the Association of Commercial Accident Insurers. (The German situation is described below.)

Escalators are utilised for the continuous transport of large numbers of people (they do not count as stairs for the purposes of building regulations) and, for example in department stores, have a pitch of 30 or 35°. The 35° escalator is more economical because it requires less space. For travel heights ≧6 m, the 30° escalator is required . The transportation capacity is about the same for both pitches. When installed as part of transport facilities, a pitch of 27–28° should be used if possible. The pitch is derived from a gradient relationship of 16 × 30 cm, a comfortable size for a step.

For the width of steps, there is a worldwide standard of 60 cm (1 person without hand luggage, no longer permissible in Europe), 80 cm (1–2 people) and 100 cm (2 people) → ❸ – ❺. With a 100 cm step width, people carrying loads have sufficient room for movement. Provide sufficient queuing room at the bottom and top of the escalator, ≧2.50 m deep.

In department stores, offices and administration buildings, trade fair halls and airports, escalator speed is normally no higher than 0.5 m/s. In underground railway stations and public transport facilities, 0.65 m/s is preferred.

The average distribution of upward traffic in department stores is: fixed stairs 2%, passenger lifts 8%, escalators 90%. Approx. three quarters of downward traffic uses the escalators. Although the average shopping area for each escalator is 1500 m² at present, this should be lowered to an optimum of 500–700 m².

Escalators in transport facilities. According to Bostrab ('Regulations on the construction and operation of trams'), there are stringent requirements (function, construction, safety) for pitches 27, 18 and 30°. Dimensions and capacities → ❶ – ❷, ❹

Length on plan → ❶

For 30° pitch = 1.732 × storey height
For 35° pitch = 1.428 × storey height

Example: storey height 4.50 m and 30° pitch (35° is sometimes not permissible abroad), length on plan: 1.732 × 4.5 = 7.794. With the level access and exit areas, this gives a length of approx. 9 m, therefore about 20 people can stand on the escalator at the same time.

LIFTS

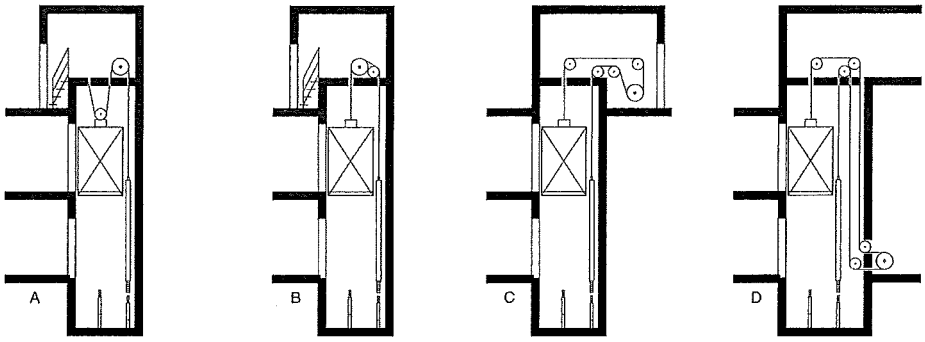
Principles

For all buildings, lifts should normally be positioned at the source of traffic flow. Provide sufficient space for waiting and queuing → p. 130 which must not infringe on stairs. Carefully plan the connection to the traffic routes. There are two different drive systems for lifts:

1. Traction sheave drive (for cable lifts) → ❶
2. Hydraulic lifts → ❷ – ❸

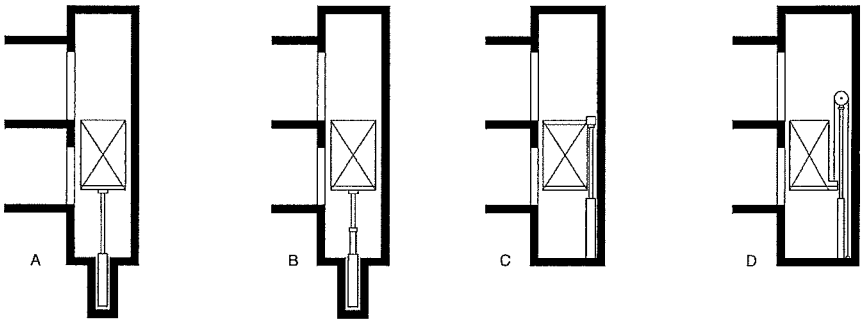
Traction lifts: ideally have their drives above the shaft. The empty weight of the car and half the live load are balanced by the counterweight. Placing the drive at the top or at the bottom next to the shaft makes necessary additional pulleys, resulting in higher operating costs. The machinery and control system can be accommodated in a separate machine room or, in the case of lifts without a machine room, placed in the shaft → p. 134.

With **hydraulic lifts**, a push cylinder is mostly used → ❷ – ❸. The lifting cylinder can be arranged directly or indirectly. The arrangement of a direct cylinder inside a protective tube under the ground is no longer suitable because of the requirements for the protection of groundwater. The use of a pull cylinder → ❸ B–D can be appropriate in some cases. A pull cylinder in its basic form balances a part of the weight of the car. This has even more effect with additional weights → ❸ D, because the pump motor runs only when the load is lifted by the cylinder, while downward travel is enabled simply by opening the valve, which requires no energy and almost halves the consumption.



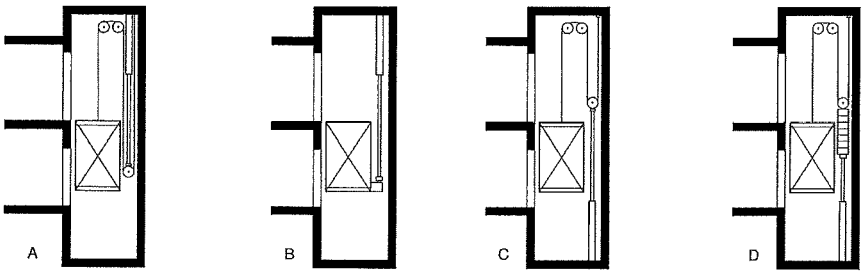
Drive at top 2:1 | Top 1:1 | Top adjacent 1.1 | Bottom adjacent 1:1

❶ Traction lifts



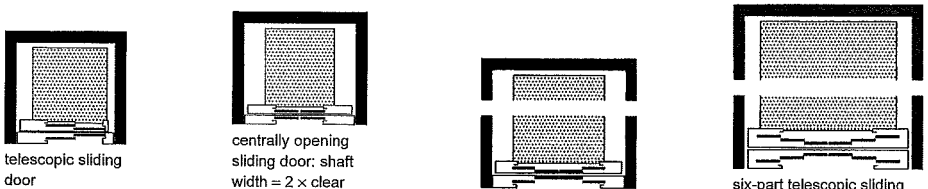
Direct drive central 1-stage | Direct central 1-stage telescopic | Direct adjacent 1-stage | Indirect adjacent 2:1

❷ Hydraulic lifts



Push piston hanging 2:1 | Pull piston hanging 1:1 | Pull piston indirect 2:1 | Indirect pull piston with additional weight

❸ Hydraulic lifts, special versions →❶ – ❷



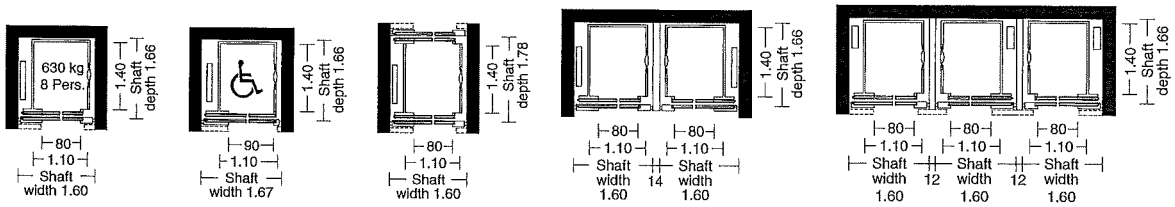
telescopic sliding door
opening to one side: shaft width = 1.5 × clear passage width + 27 cm ≧1.60 m

centrally opening sliding door: shaft width = 2 × clear passage width + 20 cm ≧1.80 m suitable for cars, which should be emptied quickly

four-part telescopic sliding door: shaft width depends on the type of drive

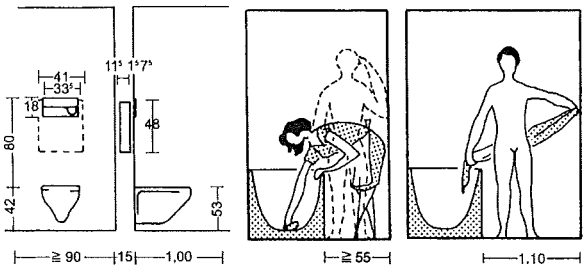
six-part telescopic sliding door: suitable for cars with wide openings e.g. in hospitals and commercial buildings

❹ Relationship of door-opening type to shaft width

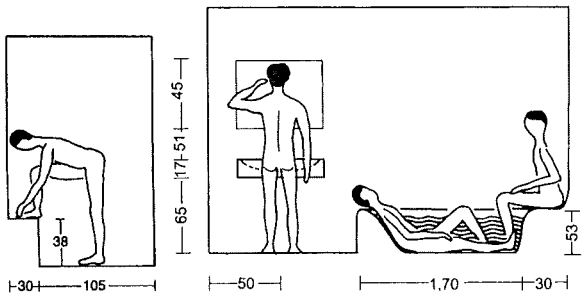


❺ Plans of lifts → p. 130 ff.

Wheelchair-suitable | Through-loading | Double | Triple



❶ Space requirements in bathroom (guideline values). Room between bath and wall



❷ In the shower At the washbasin Bathing and sitting

Details and fitting out

The former standard valid for movement areas in bathrooms was withdrawn without replacement in 2007, because it inadequately considered the requirements of disabled people. The dimensions given here should therefore be considered as absolute minimums. **The movement areas in bathrooms should generally be based on the 'Accessible building' standard** → ⓫ → p. 21 ff.

The basic bathroom categories are: (guest) **WCs** with WC and washbasin → ❸ – ❹, **shower rooms** with shower and basin → ❺ – ❻, **bathrooms** with bath, washbasin and WC → ❼ – ❽, **full bathrooms** with bath, shower, washbasin and WC → ❿.

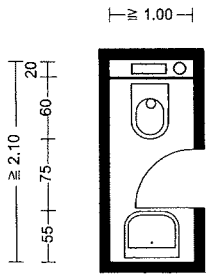
Because of the high humidity and resulting **condensation**, the surfaces must be **easy to clean**. Wall and ceiling plaster should be able to absorb and release enough moisture. Floor coverings should be sufficiently **slip-resistant**. If there is no laundry room, the bathroom must be designed with space and connections for a **washing machine**, washer/dryer and laundry basket.

One **earthed socket** is to be provided (next to the mirror). In addition, the following should be included in the design of bathrooms and WCs: cupboards for towels and cleaning materials, lockable medicine cabinet, towel rail (perhaps with additional heating), hand grips above the bath.

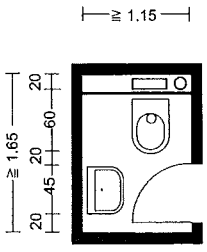
Residential buildings

ROOMS
Access
Kitchens
Living areas
Bathrooms
Subsidiary rooms
Garages

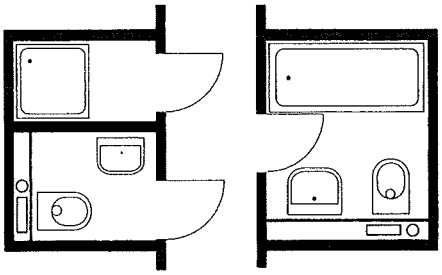
see also:
Accessible building p. 21
Sound insulation p. 477



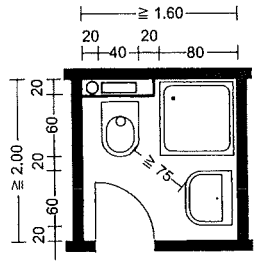
❸ WC with washbasin



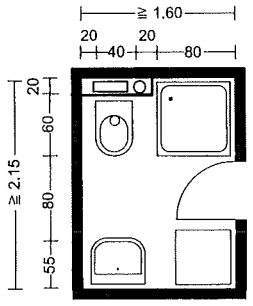
❹ WC with handbasin



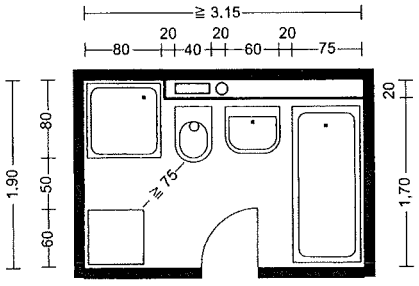
❾ Functional split of the bathroom into separate rooms



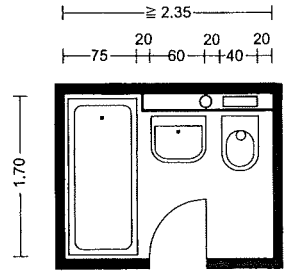
❺ Space required for shower



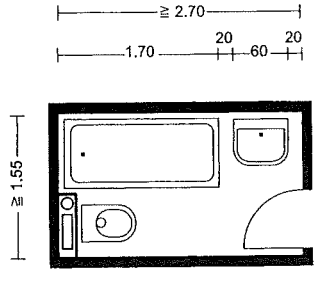
❻ Shower room with washing machine



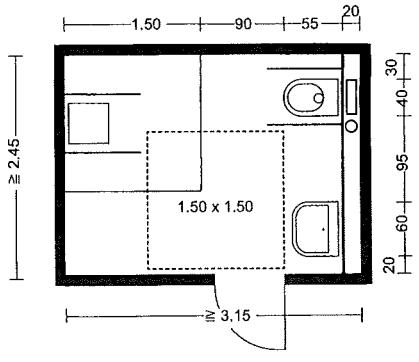
❿ Full bathroom with space for washing machine



❼ Space required for bathtub



❽ Full bath



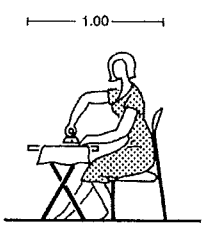
⓫ Accessible bathroom with showering space

Laundry/utility rooms

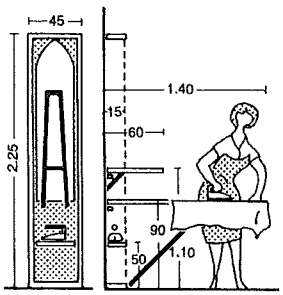
Laundry/utility rooms are used to carry out domestic work like washing and drying clothes, ironing and sewing. They can also be storage rooms for small items of equipment, detergents, cleaning agents and polishes, buckets and vacuum cleaners, tools and ladders. The provision of a laundry/utility room is particularly useful in flats, despite the additional space required.

These rooms are best placed to the northeast, next to or easily accessible from the kitchen → ❹ – ⓮. In this way, tasks can be combined and carried out by one person. In detached houses, direct access should be provided to the garden (for drying laundry).

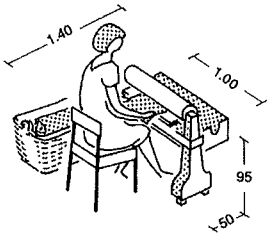
In the design of utility rooms, a comfortable and healthy arrangement of appliances is important: An ironing board used in the standing position requires a different height to one that is used seated → ❶ – ❸. A fully adjustable ironing board is ideal. A worktop of 1.20 m width should be provided to deal with the washing. Good uniform lighting is required in the working area of the laundry/utility room (average light intensity ≈ 350 lx).



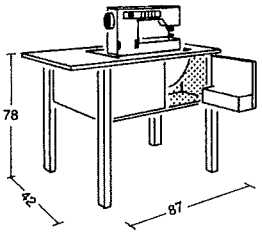
❶ Space required for ironing while seated



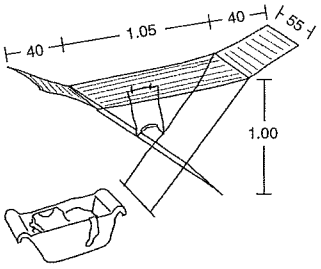
❷ Built-in cupboard for ironing board



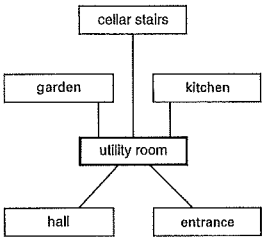
❸ Ironing machine



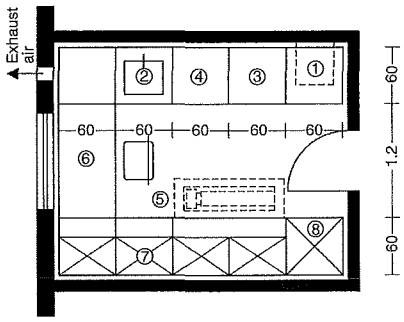
❹ Sewing machine



❺ Space required for clothes horse

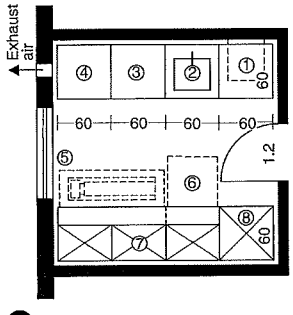


❻ Scheme of relationships of rooms to the laundry/utility room



① Dirty washing (chute)
② Washbasin
③ Washing machine
④ Washer/dryer
⑤ Ironing machine
⑥ Work top
⑦ Wall cupboard
⑧ Tall cupboard

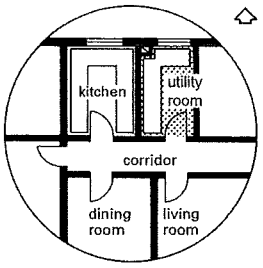
❼ U-shaped laundry/utility room



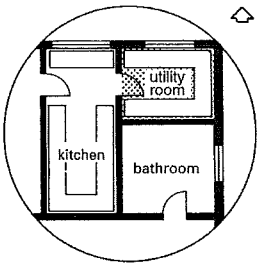
❽ Two-lane laundry/utility room

Equipment and appliances	Width (cm)	Better
automatic washing machine and washer/dryer above each other	60	60
washbasin with water heater	60	60
laundry basket	50	60
washing worktop	60	120
ironing machine	approx. 100	100
cupboard space for minor equipment	50	60
total	approx. 380	460

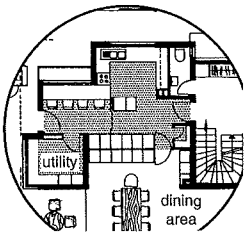
❾ Equipment and space required



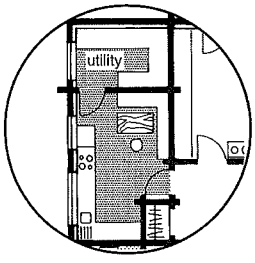
⓾ Next to the kitchen, accessible from the corridor



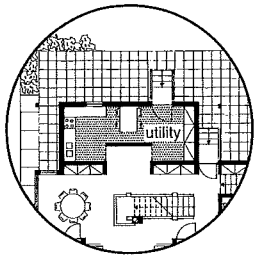
⓫ Accessible from the kitchen



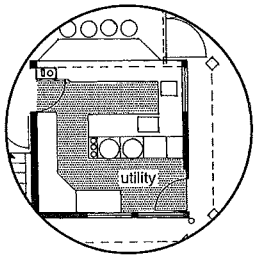
⓬ Kitchen–eating area–laundry/utility room



⓭ Next to eating area



⓮ Kitchen–eating area–laundry/utility room

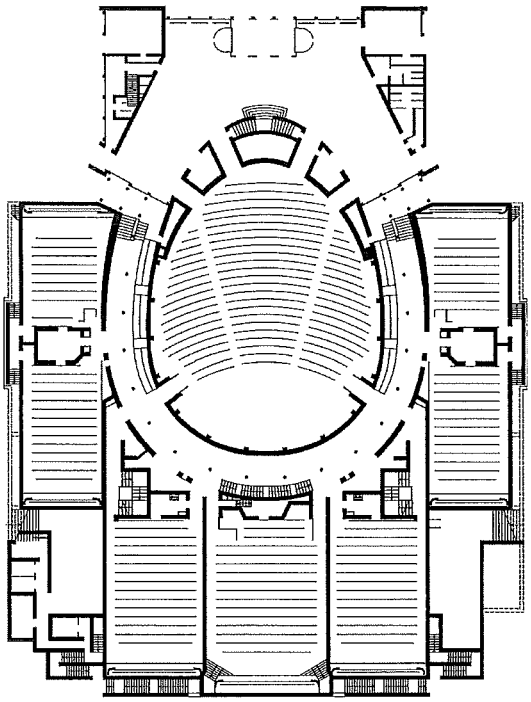


⓯ One-room kitchen and laundry/utility room

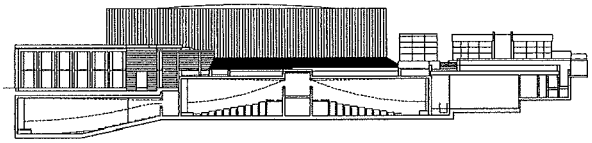
CINEMAS

Multiplex Cinemas, Examples

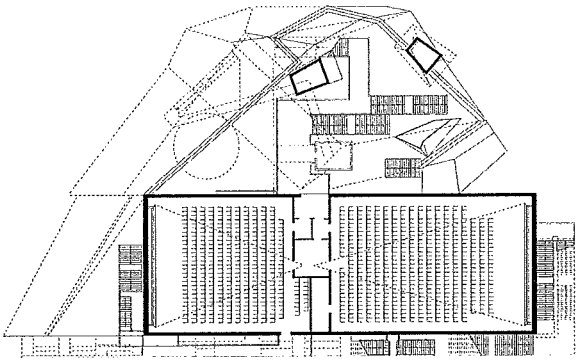
The town-planning situation plays a significant role in the number of cinema screens that can be combined into a unit. Possible forms are layered stacking (screens stacked as a cube, access and service functions connected in free form at the side) → ❸ – ❹, or a horizontal row of screens (larger cinemas from the 1960s were extended with further screens, sunk into the ground for conservation reasons) → ❶ – ❷ or combination forms. A common form is the combination with other functions like shopping centres and car parks, with sales areas on the ground floor, cinema screens and parking on the first floor: a prominent urban landmark in conjunction with two high-rise point buildings → ❺ – ❼.



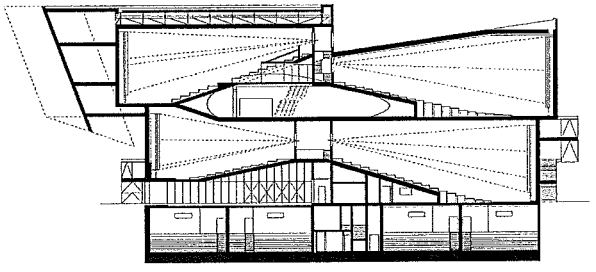
❶ Kosmos cinema, Berlin, plan Arch.: Rohde Kellermann Wawrowsky



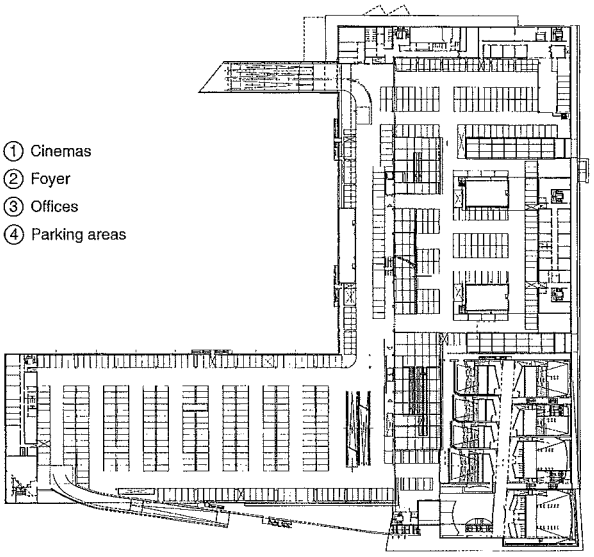
❷ Kosmos cinema, Berlin, elevation/section Arch.: Rohde Kellermann Wawrowsky



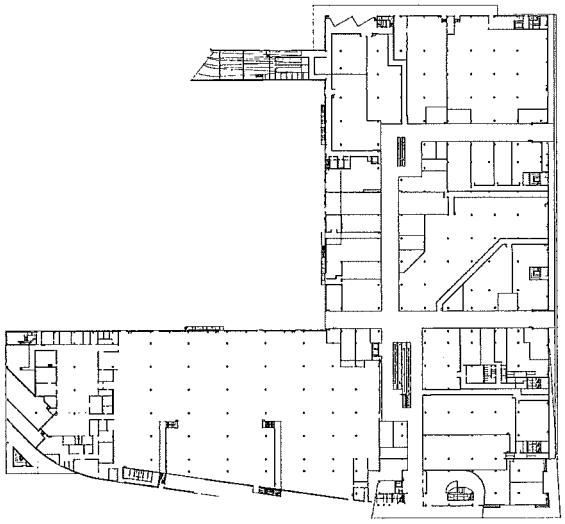
❸ Filmpalast Dresden, plan Arch.: Coop Himmelb(l)au



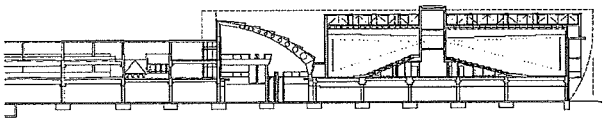
❹ Filmpalast Dresden, view/section Arch.: Coop Himmelb(l)au



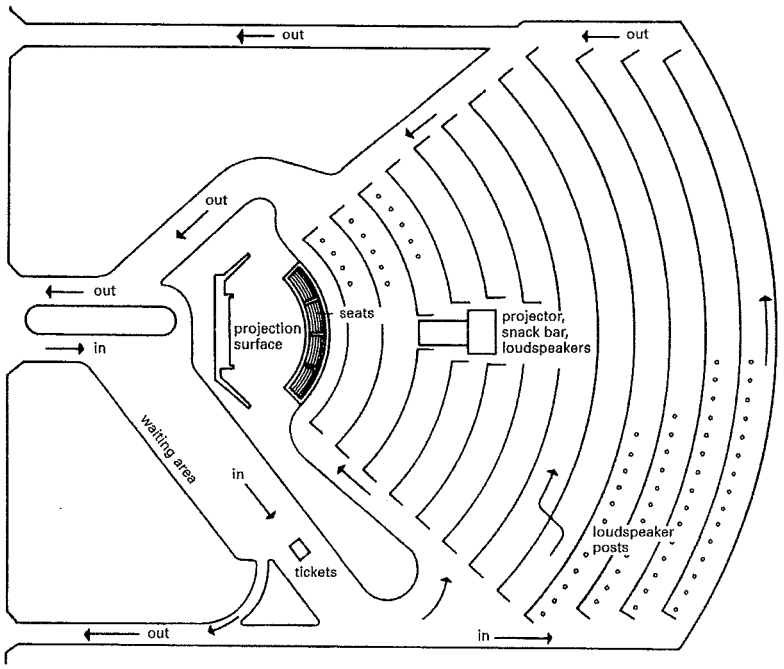
❺ Neustadt Centrum Halle, first floor plan (cinema level 1)
Arch.: Hermann & Valentiny with Noack und Partner



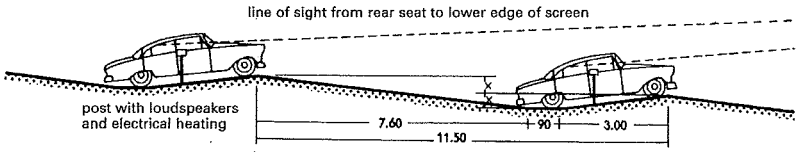
❻ Neustadt Centrum Halle, ground floor plan (shopping level)
Arch.: Hermann & Valentiny with Noack und Partner



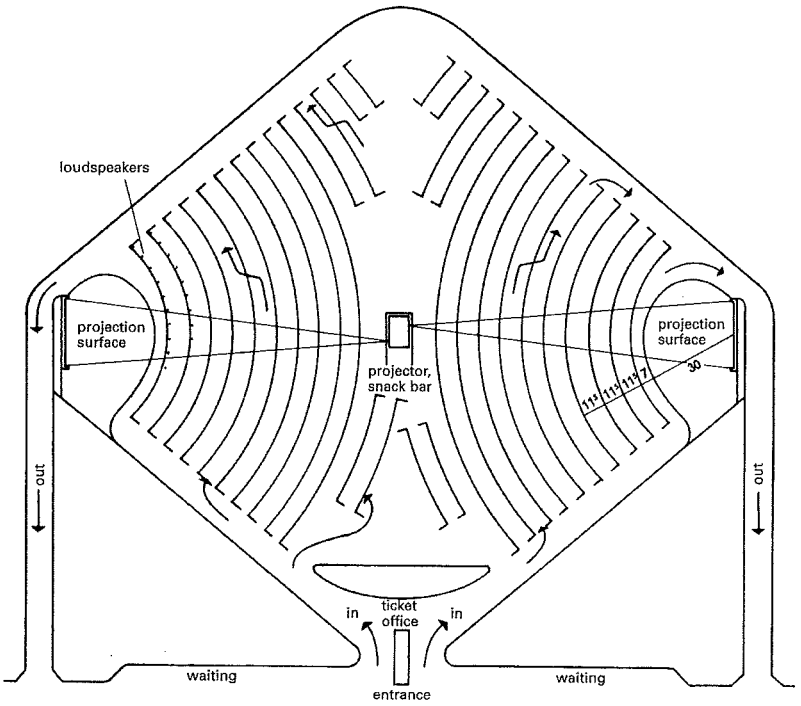
❼ Neustadt Centrum Halle, section
Arch.: Hermann & Valentiny with Noack und Partner



1 Drive-in cinema in a fan shape with inclined ramps and low projection cabin, which only takes up two rows



2 Ramp arrangement and dimensions: elevations can be different according to screen picture height



3 Double cinema. One projection room for both screens, with the possibility of staggered starting times. All other areas (cash desks, bar, toilets etc.) are common

CINEMAS

Drive-in Cinemas

Drive-in cinemas, where the audience do not have to leave their cars.

The size is limited by ramps, number of cars ≦1000–1300, while still ensuring a good view. Normal is 450–500 cars → ❶.

Cars	No. ramps	Screen to back edge of ramp (m)
500	10	155
586	11	170
670	12	180
778	13	195
886	14	210
1000	15	225

Location: on the motorway, near petrol stations and services, with screening so that light and sound do not distract passing traffic.

Ramps are curved and sloping in order to lift the front of the cars, so back seat passengers also have a good view of the screen → ❷.

Entrance road: with waiting area, in order to avoid backing up of traffic on the road. Drive-past ticket counter, so that tickets from the cars can be checked → ❸.

Exit: ideally after leaving the ramp forwards.

Detailing of the entire area to avoid dust and skidding in wet weather.

Ticket counter: one counter for 300 cars; two for 600; three for 800; four for 1000.

Screen: depends on the number of cars: for 650 cars 14.50 × 11.30 m; for 950 cars 17.0 × 13.0 m. Ideally facing east or north, which enables earlier performances. For the Central European latitude, the screen is better installed in a solid, permanent structure.

Cinema screen in the Billbrook drive-in cinema near Hamburg: 36 m high × 15.5 m wide. Height above ground level depends on ramp gradient and sight angle. Screen tilted upward avoids distortion. Scaffolding and screen must be able to bear wind loading.

Rows of seats should be provided, and a play area for children is also a good idea.

Projection building: mostly central, at a distance of 100 m from the screen.

Projection room contains projectors, generators, sound amplification system.

Sound reproduction ideally has loudspeakers inside the cars; the loudspeakers are attached to a post for every two cars at 5.0 m separation and are attached inside the cars by the visitors.

Heating: on loudspeaker posts, possibly also a connection for heating in the cars.

CIRCUS

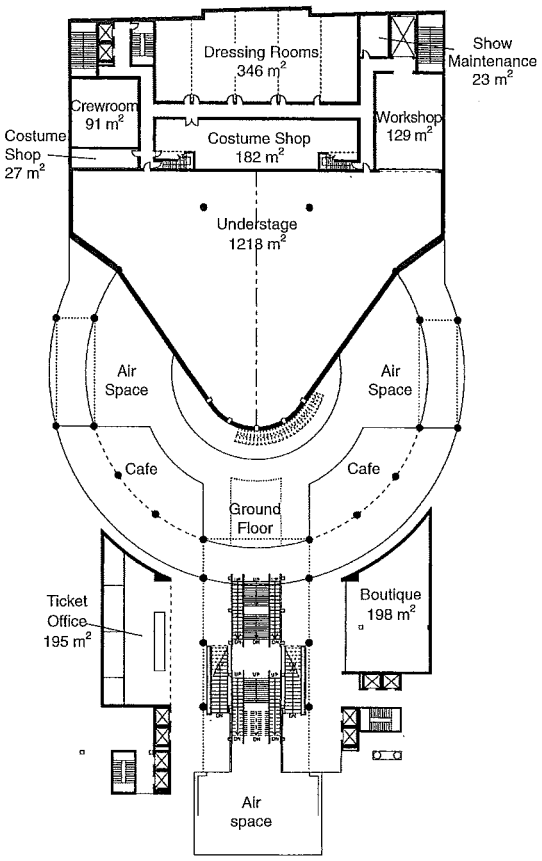
Stationary

Show theatre, permanent venue

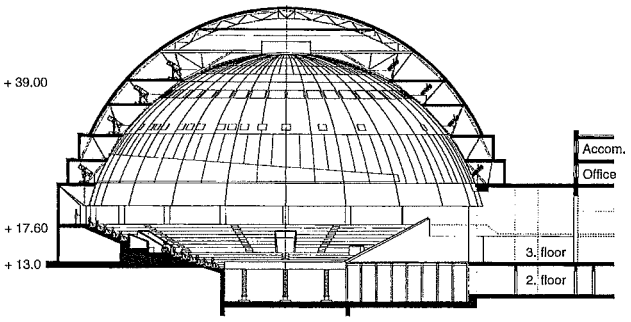
Amphitheatre-type hall, laid out as three quarters of a circle, offering seats for an audience of 1600. The last quarter is intended for the stage, which consists of five stacked lifting platforms. This enables the stage sets to be changed very quickly → ❸.

Access to the hall on the third floor + 13.00 m above road level. A 27 m high reinforced concrete dome spans the circus arena.

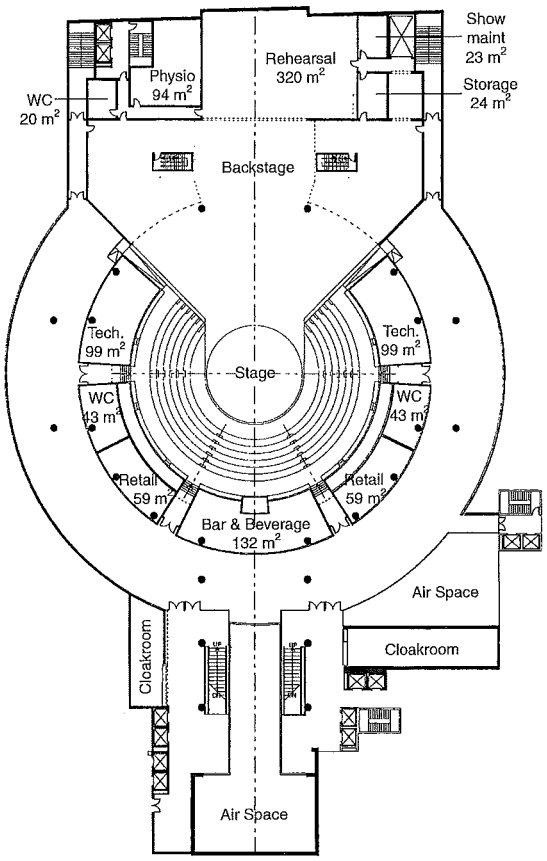
Project: Berlin Leipziger Platz
Arch.: Aldo Rossi Milan
Planungs AG Neufert/Mittmann/Graf, Berlin
Sceno-Plus Experts-Conseils, Montreal



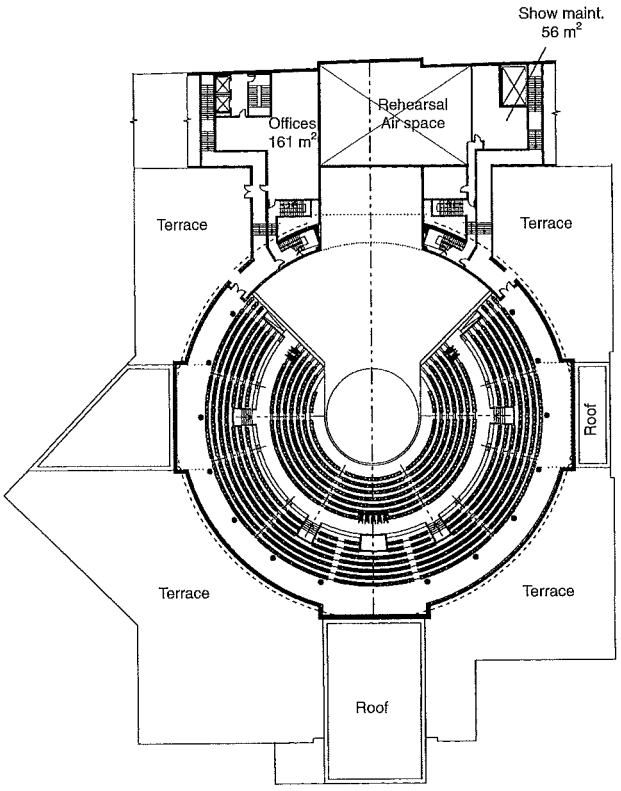
❶ Second floor + 9.00 m (underfloor theatre)



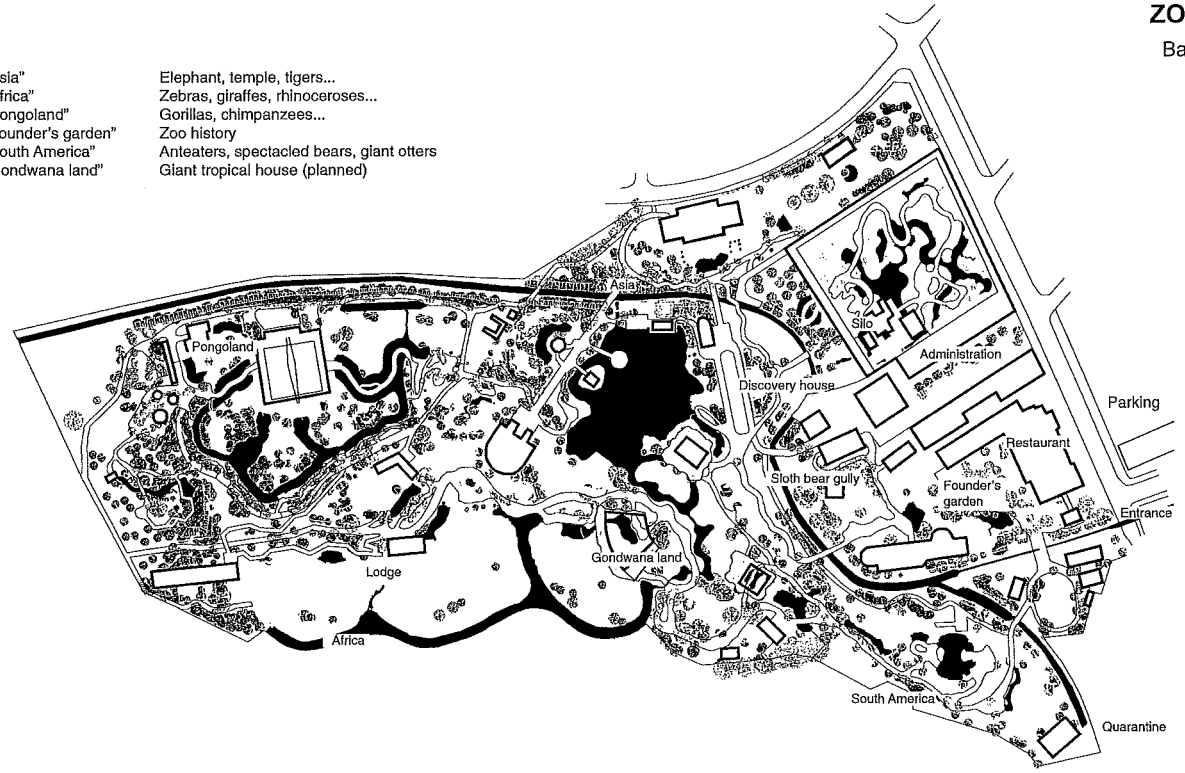
❸ Section



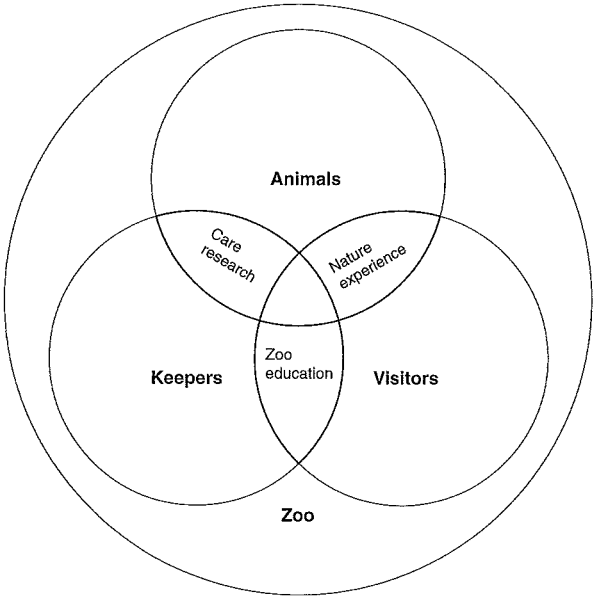
❷ Third floor (stage area) + 13.00 m



❹ Fourth floor (audience seating level) + 16.50 m



❶ Master plan of a modern zoo with adventure world (animal geography), from the example of Leipzig Zoo Arch.: Rasbachr Architekten



The modern zoo attempts to balance the interests of research, animal protection and the experience of nature.
On one side stand the requirements for keeping the animals, feeding, cage design and veterinary care in line with the needs of the species, research activities for the conservation of species, participation in international breeding programmes and zoo educational publicity work.
On the other hand, the zoo is also a business, whose success mainly depends on visitor numbers and is in competition with other leisure providers.
The basis of any zoo design is therefore the orientation on the state of research into the keeping of animals in a way suitable for the species, and also the consideration of the demands of the potential visitors. The staging of exotic ("near to nature") animal worlds and spectacular visitor facilities should therefore be evaluated against this background.

❷ Tasks of the modern zoo, combining the interests of research, animal conservation and providing exciting experiences

Objectives of zoos
Starting with Directive 1999/22/EC, zoos are subject to the following requirements → ❷:

1. Involvement in research activities for species conservation
2. Zoo educational publicity work
3. Keeping and feeding the animals correctly for the species
4. Protection against animals escaping or pests and vermin infiltrating
5. Keeping a register of the zoo collection

Infrastructure of a modern zoo → ❶
Access: good accessibility, clear signposting, sufficient number of parking spaces, stops for public transport

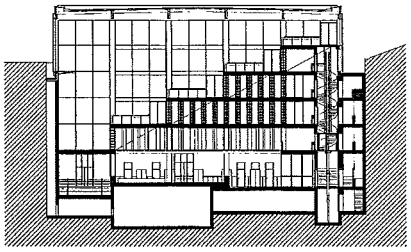
Main entrance: distinctive entrance area, pay booths/counters, kiosks, administration, tidy paths, welcoming seating

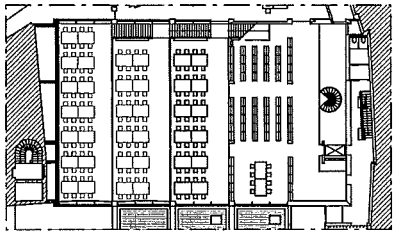
Further infrastructure: event and lecture room, high-class restaurant with view of zoo facilities and separate entrance from outside (for evening business), further restaurants according to zoo size, self-service cafeteria, kiosks, toilets, picnic sites, zoo shops, zoo school

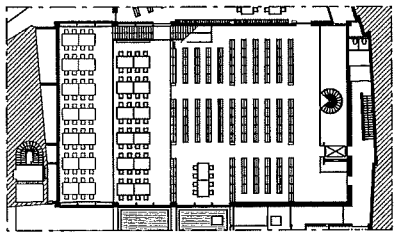
Operations and staff building: separate access (out of public view) with adequate external areas for the storage of feed and litter, building materials, etc., staff department with washing and changing facilities, cafeteria, training and rest rooms (security staff), breeding of feed animals, central/dispersed feed preparation, water distribution, storage and cool rooms, rubbish removal, sheds for parking and maintenance of cleaning machines, transport vehicles and cages, workshops, gardening, heating, air conditioning, ventilation

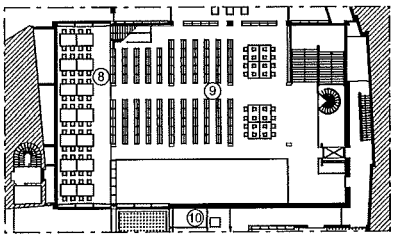
Medical care of animals: animal clinic, quarantine station, laboratories, research facilities, acclimatisation and breeding areas, cadaver storage

Access roads and paths: wheelchair-accessible main paths (5–6 m wide), with weather protection, laid out as round route, side paths (3–4 m wide) to each group of animals, independent operational roads (3–4 m wide) for supply, waste disposal, animal transport and as emergency access (fire service, ambulance).

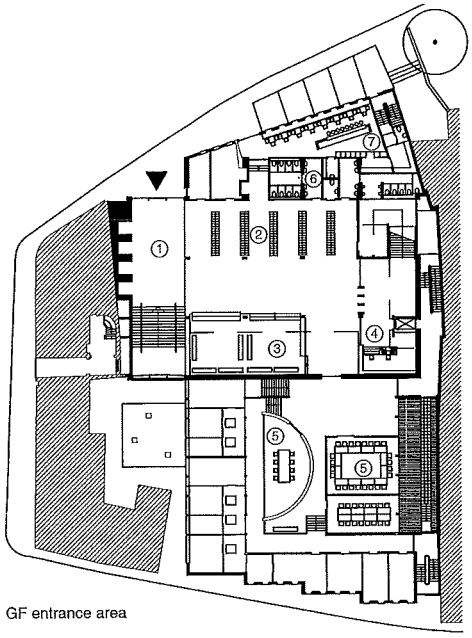

Section reading room


3rd floor reading room


2nd floor reading room



1st floor reading room



GF entrance area

❶ Juridicum Halle: specialist law library, Halle University, Wittenberg

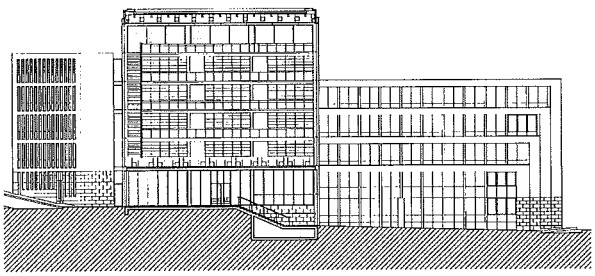
Scientific libraries have always had a key role in the history of science and in the life of universities. They are not only a location for storing books, but places where books can be worked with. An important and decisive part of world literature has been produced in libraries. Their erection is among society's greatest building projects. Important architectural examples from the 19th century show what high prestige has been applied to the task (Biblioteca Laurentiana, Florence; Bibliothèque Nationale, Paris).

They collect and access printed publications and other information media for education and research, and offer it for use in reading rooms (stock which is not lent out) and also for lending from the closed stacks, the self-service shelves and, to select in the reading rooms, separately displayed teaching material or specially gathered collections for one term. As well as books and magazines, most other types of audiovisual media are collected, catalogued and available for use. The number of reading places is related to the number of students in the various subjects. Orientation is provided by systematic classification of stock by subject. The services offered include remote lending (obtaining literature from distant libraries), copying services and enlargement of micro-forms (microfiche and microfilm).

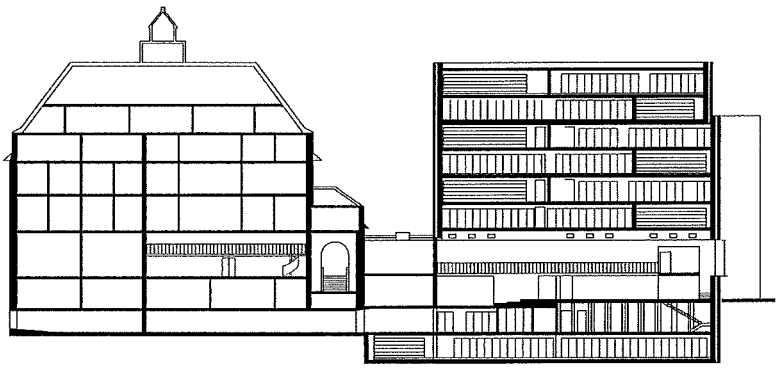
Example: Juridicum Halle → ❶ – ❷.

University libraries
These are single- or two-storey buildings: single-storey systems are centrally administered (book processing and services) and mostly have at least a few separate user areas in branch or specialist libraries. Two-storey libraries include a central library and an (often larger) number of libraries for faculties, specialist areas and institutes. Stock is often freely available in reading rooms, often in self-service stacks (shelving units spaced as in closed stacks) and in closed stacks, the different forms of display being mixed in most university libraries. The ratio of stored to display and lending stock is determined by the structure of the stock, and/or the organisation type or library concept, and often also the space available in existing buildings.

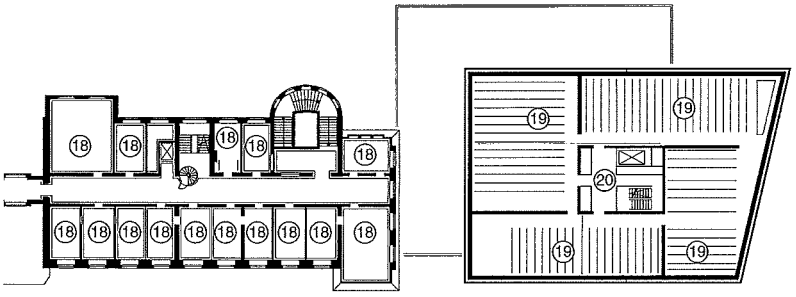
① Main entrance
② Lockers
③ Waiting area
④ Staff/supervision
⑤ Exam room
⑥ WC
⑦ Café, accessible from outside
⑧ Reading places
⑨ Bookshelves
⑩ Computer places



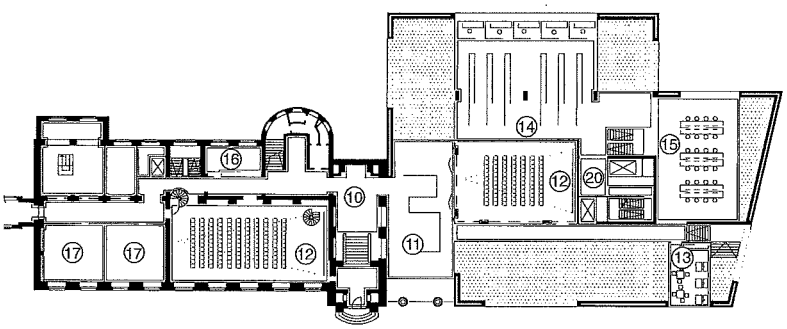
❷ Juridicum Halle, section Arch.: Thomas van den Valentyn, Gernot Schulz



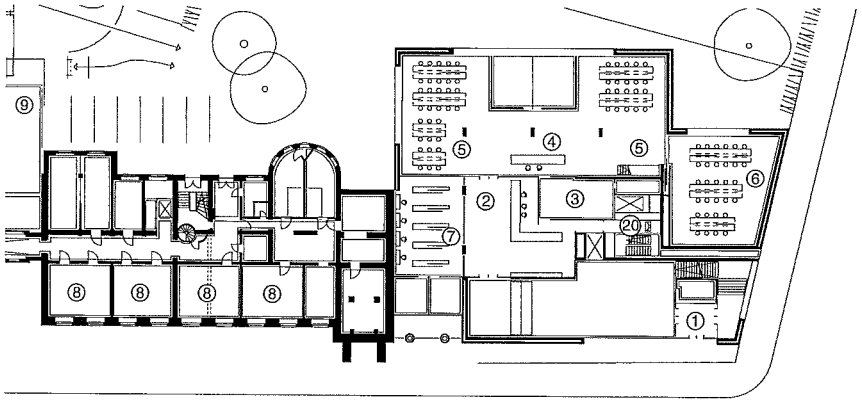
1 Extension of the State Archive in Dresden, section through old building and new archive building
Arch.: Kister Scheithauer Gross



2 The archive storerooms are arranged round the access and ventilation core. The room can be flexibly divided due to the three entrances. Pre-stressed concrete slabs enable thin floor structures with high loadings, so that space-saving rolling storage units can be used.



3 First floor serves to connect to the old building and houses seminar rooms, cafeteria and reading room.



4 Ground floor and first floor serve public functions. The foyer in the new building enables disability-friendly access and connection to the old building.

LIBRARIES

Archives

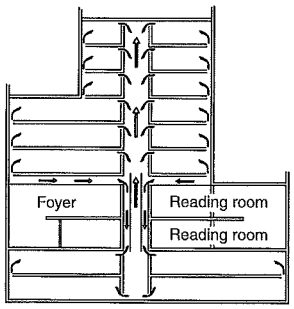
Basics

Archives do not, unlike libraries, serve mainly to make available written, graphic and audio media, but for their systematic cataloguing and long-term preservation.

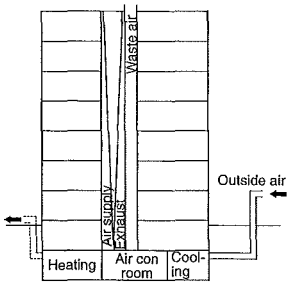
In this function, they are often part of libraries, museums or universities. State archives keep all sorts of files, business records, maps, drawings and documents.

In order to be able to accept the rapidly increasing stock, suitable storage systems such as rolling shelving units or plan chests (→ pp. 237, 248) must be provided. The loading on the floor slab should be paid particular attention (→ p. 248). For the durability of the preserved media, the maintenance of a uniform climate is the most important factor, but full air conditioning has not proved acceptable on account of the high cost. Natural ventilation is the ideal, but also brings the danger of entry by air-borne pollutants. Systems without air conditioning need solid walls with the best possible diffusion values, and the temperature should be maintained by simple wall surface heating (skirting radiators).

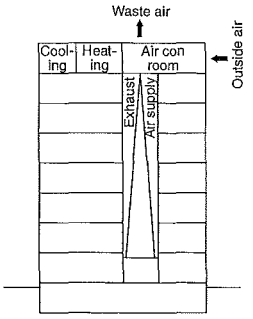
① Controlled access for users
② Information, issue
③ Store
④ Supervision
⑤ Reading room
⑥ Map reading room
⑦ Search aids
⑧ Workshops
⑨ Delivery
⑩ Staff access
⑪ Display
⑫ Seminar/ lecture
⑬ Bistro/café
⑭ Self-service films
⑮ Film reading room
⑯ Post room
⑰ Director
⑱ Administration
⑲ Archive rooms
⑳ Stair and ventilation core



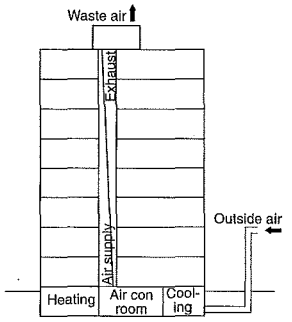
5 Principle of source ventilation: prepared air is blown in through shafts and fed to the floors through ventilation blocks.



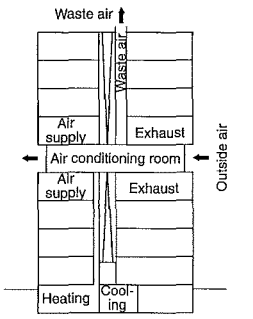
❶ Air conditioning plant rooms in basement (Wellpott → refs)



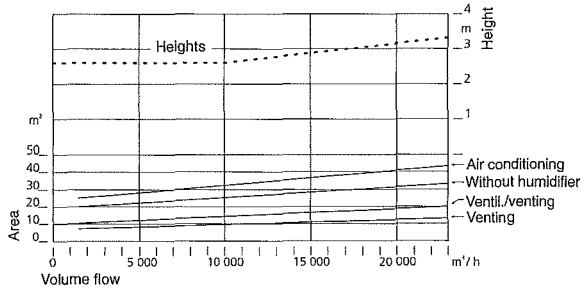
❷ Air conditioning plant rooms on top floor (Wellpott → refs)



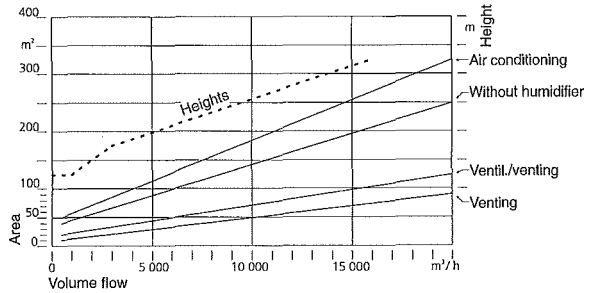
❸ Air supply plant room in basement. Extract air plant room on the roof (induction air conditioning system). No air circulation (Wellpott → refs)



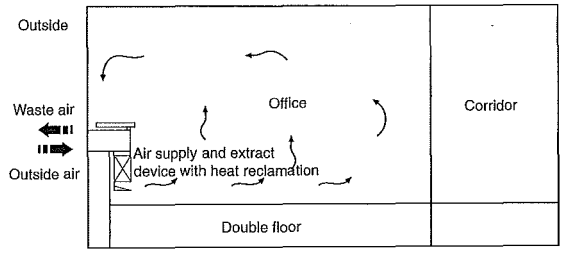
❹ Air conditioning plant room on an intermediate floor. Good solution for high-rise buildings (Wellpott → refs)



❺ Approximate determination of area and room heights required for air conditioning plant rooms in which to site several units for air flows of up to 50m³/s, according to Vdl 3803, for smaller systems (Wellpott → refs)



❻ As ❺, but for larger systems (Wellpott → refs)



❼ Combined parapet air supply and extract unit (Wellpott, Bohne → refs)

Air conditioning plant rooms →❶ – ❹

Arrangement for air handling equipment According to a sample design by the expert Building Supervision (RbAL), air handling equipment must have a dedicated service room (air conditioning plant room) in buildings of more than three storeys, if the connecting ductwork leads into more than one storey or fire compartment.

Ventilation and air conditioning systems mostly have their services rooms on a services floor, near the heating plant room (heating room with distribution) and the cooling plant (chiller). The combination of air conditioning plant and heating plant in one room is not allowed (fire protection). Spatial connection of plant rooms to the building cores with their vertical installation shafts is an important design consideration. The horizontal and vertical distances to the main areas of demand (e.g. large kitchens, canteens or server rooms) from the air conditioning plant room should also be considered.

The formal integration of a services floor into the body of a building can considerably influence its appearance. Placed on one of the upper storeys, a dedicated services floor will have almost no windows or none at all (noise emission), but will need intake and extract louvres and will also contrast with other floors with its different storey height.

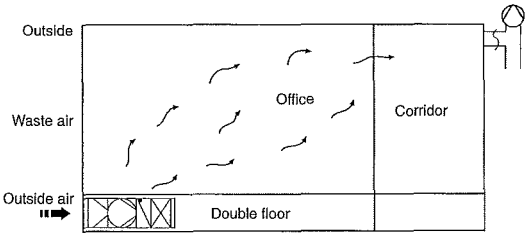
Room sizes

An approximate estimation of the size of an air conditioning plant room can be undertaken using the VDI Guideline 2052, working from the assumed volume flow and the type of air handling. Example calculations for the size of the plant room in an administration building → ❺ – ❻.

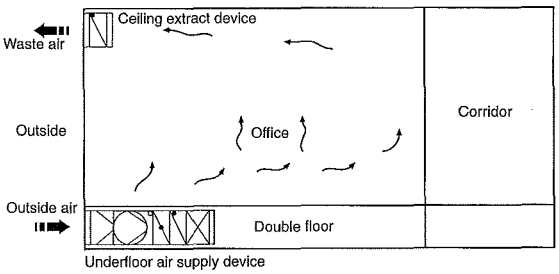
Façade ventilation systems → ❼ – ❾

These are also referred to as **decentralised ventilation systems.** The units are placed near the façades with a direct duct connection. In contrast to fan convectors with recirculation, the flow of outside air is fed directly from the façade to the unit. This means that no more air conditioning installation is required in the building. Façade ventilation units can be designed in various forms such as underfloor air supply units, combined air supply and extract units or with a central extract air plant.

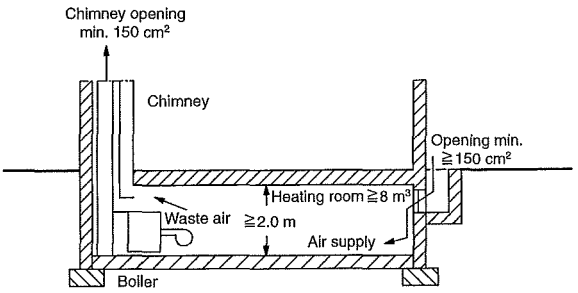
It is important to consider the influence of wind pressure on the volume flow. The temperature boundary layer at the façade can also affect the air supply temperature, depending on the layout and design of the building.



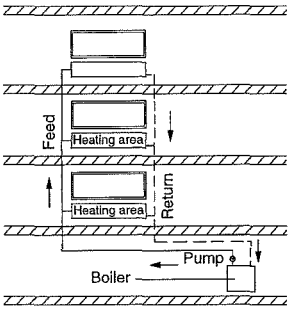
❽ Underfloor air supply unit combined with centralised extract air system (Wellpott, Bohne → refs)



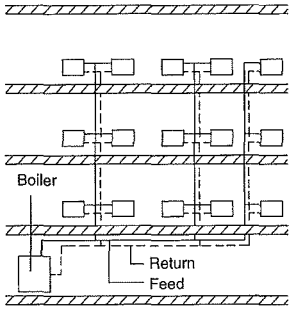
❾ Underfloor air supply unit combined with over-current component (Wellpott, Bohne → refs)



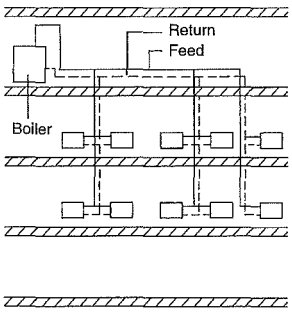
❶ Heating room for solid fuel, min. area 8 m³ necessary for heating capacity ≧50 kW



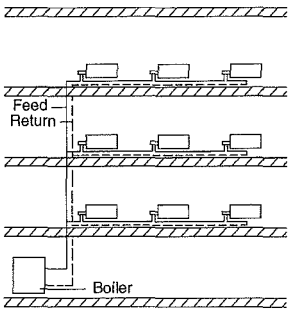
❷ Principle of warm water central heating system: water is heated by the boiler and circulated constantly to radiating surfaces by a pump (Wellpott → refs)



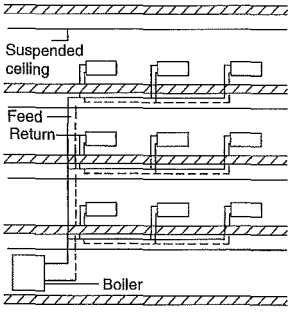
❸ Twin-pipe system with low-level distribution and vertical riser connections



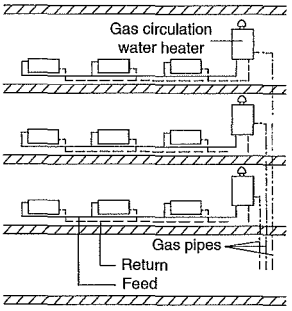
❹ Twin-pipe system with high-level distribution and vertical riser connections



❺ Single-pipe system with special valves and horizontal distribution



❻ Twin-pipe system with horizontal distribution (standard layout for office buildings)



❼ Single-pipe system with horizontal distribution on each floor

Heating systems

Heating systems for buildings normally use water as the heat distribution medium, less often air (steam is used as a heating medium only for industrial purposes). The necessary temperature of the heat distribution medium (water, air, steam) depends on the temperature chosen and the type of heating surface in the rooms. A heat generator provides the necessary temperature. Most existing heating systems use gas or oil as the primary energy source. The heating gas or oil is normally burnt in boilers with a combustion temperature of about 1000°C and the heat is transferred to the distribution medium in a heat exchanger.

Because a temperature of 70°C is typically sufficient for the heat distribution medium, a holistic design will attempt to avoid the burning of fossil fuels. Methods of exploiting renewable energy are: (ground-source) geothermal energy → p. 469 in connection with a heat pump system; combination of heat and power generation (CHP); or perhaps falling back on a CO_2-neutral energy source like wood. It can also be possible to store seasonal sources of energy from the environment (thermal solar energy) during the summer months and make it available in the winter.

Heat distribution

Much the most common system is **warm water central heating.** This transfers the heat produced in the heat generator into water as distribution medium to the radiators, which emit heat. The cooled water returns to the heat generator to be warmed up again (flow and return). Warm water central heating systems have a max. flow temperature of approx. 100°C, but 45–70°C is normally preferred today, described as the low temperature range. Heating systems with flow temperatures of over 120°C count as hot water heating and are more often used with district heating systems.

The heat distribution is normally circulated as **warm water pumped heating.** There are various pipework layouts → ❷ – ❼.

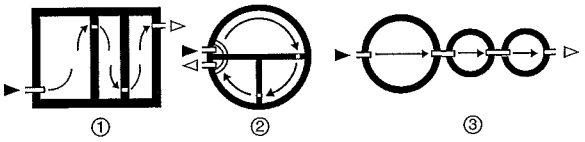
Heat generation with gas or heating oil

Gas firing: gas has become prevalent in recent years. Advantages: no storage costs, low maintenance costs, payment after use, can be used in groundwater protection zones, easily regulated, high annual efficiency, can be used for the heating of individual flats or rooms (compact gas boilers), little environmental impact. Disadvantages: dependent on public utility network, higher energy costs. A conversion from oil to gas usually makes a new chimney necessary.

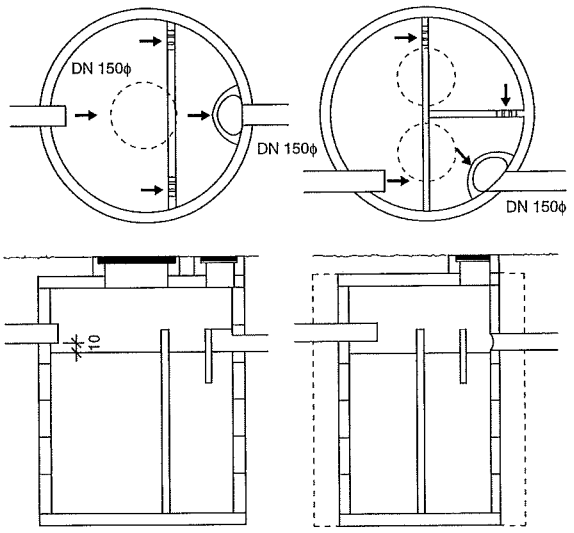
Oil firing: is also common today using light heating oil as fuel. Advantages: requires no public utility network, easily controllable. Disadvantages: high cost of storage and tank installation, rent income losses in rented houses due to the oil storage room, only possible under stringent regulations in areas at risk of flooding or groundwater protection zones, payment before use, high environmental impact.

Solid fuel firing

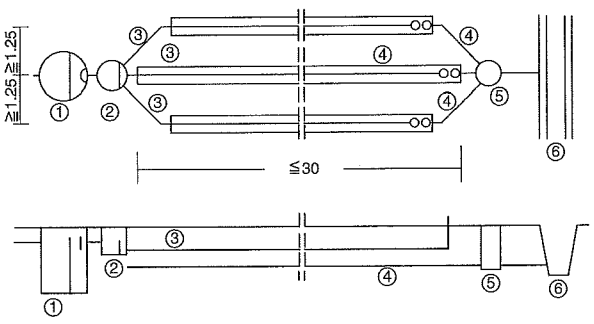
Coal, brown coal and wood are now used less often for heating buildings. Depending on the fuel, large quantities of environmental pollutants can be released, which are subject to stringent controls under the Federal Anti-Emissions Law. Advantages: independent of fuel imports, low fuel costs. Disadvantages: more work for the operator, larger storeroom necessary, high emission of pollutants, poor controllability.



❶ Basic layouts of multi-chamber sedimentation tanks



❷ Multi-chamber sedimentation tanks of pre-cast components, with two or three chambers, plans and sections



❸ Principle of a filter trench, plan and section
❶ Multi-chamber sedimentation tank, ❷ distribution shaft, ❸ feed pipes, ❹ drainpipes, ❺ collection shaft, ❻ discharge

Small sewage treatment plants are facilities for the cleaning of wastewater, which are used when the disposal of wastewater in municipal treatment works is not possible for technical, regulatory or financial reasons: maybe there is no public sewer network available, or as a temporary measure. They are only permissible for the treatment of wastewater from, for example, kitchens, laundries, bathrooms, toilets and wash rooms.

Principle of a small-scale sewage treatment plant:

1. Mechanical cleaning, i.e. sludge removal from a multi-chamber sedimentation tank → ❶ – ❷.
2. Biological cleaning in a filter trench or trickle filter or through underground filtration.

The construction of a small-scale sewage treatment system consists of: multi-chamber sedimentation tank, distribution shaft, filter trench (trickle filter or underground filtration), collection shaft, discharge into waterway.

Treatment process

The residential wastewater is first fed into a sedimentation tank (mechanical cleaning), where solid matter settles to the bottom. It then flows into a distribution shaft, from where it is fed intermittently into a filter trench (with perforated pipes) or into a trickle filter (biological cleaning). The outflow pipes from the filter trench drain via a collection shaft into a waterway or soakaway.

The mechanical process of wastewater treatment takes place in a **multi-chamber sedimentation tank**. Undissolved solids and solids capable of settling are sedimented (sludge removal) → ❶ – ❷.

Biological cleaning (secondary treatment) of the wastewater takes place in a **filter trench**. The wastewater percolates from a perforated pipe into a layer of fine gravel (2–8 mm), the filter layer, into a deeper perforated pipe (depth min. 1.25 m). This then transports the water for discharge into a waterway → ❸.

Wastewater production

For a residential building, 150 l of water per occupant per day should be assumed. For other buildings, the equivalent inhabitant value is 150 l for every:

– 3 seats in pubs without kitchens
– 1 seat in pubs with kitchens and max. 3 rotations of each seat in 24 hours.
– 10 seats in pubs with gardens but without kitchens
– 2 employees in factories or workshops without kitchens
– 3 employees in administration buildings without kitchens.

	Multi-chamber sedimentation tanks		Multi-chamber septic tanks
no. chambers	2	3–4	3
specific usable capacity	300 l/RU*	300 l/RU*	1500 l/RU*
total usable capacity (min.)	3000 l	3000 l	6000 l
total usable capacity (max.)	4000 l	—	—
capacity of 1st chamber	⅔ of total capacity	½ of total capacity	½ of total capacity
min. water depth	1.20 m	1.20 m	1.20 m
greatest permissible water depth for usable capacity of 3000–4000 l >4000–10000 >10000–50000 l >50000 l	 1.90 m — — —	 1.90 m 2.20 m 2.50 m 3.00 m	 1.90 m 2.20 m 2.50 m 3.00 m
*RU, each residential unit with 50 m² of residential area is assumed to have 2 inhabitants, over 50 m² min. 4 inhabitants.			

❹ Sizing of multi-chamber sedimentation tanks and septic tanks, DIN 4261-1

inch(")	1/16	1/12	1/8	1/6	3/16	1/4	5/16	1/3	3/8	5/12	7/16	1/2
mm.....	1.59	2.12	3.18	4.23	4.76	6.35	7.94	8.47	9.52	10.58	11.11	12.70
inch (")	9/16	7/12	5/8	2/3	11/16	3/4	13/16	5/6	7/8	11/12	15/16	1
mm.....	14.29	14.82	15.87	16.93	17.46	19.05	20.64	21.17	22.22	23.28	23.81	25.40

English foot and inch to millimetres
1 ft = 304.79973 mm

ft	in	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"
0	**0**	0	25.4	51	76	102	127	152	178	203	229	254	279	305
1	**12**	305	330	356	381	406	432	457	483	508	533	559	584	610
2	**24**	610	635	660	686	711	737	762	787	813	838	864	889	914
3	**36**	914	940	965	991	1016	1041	1067	1092	1118	1143	1168	1194	1219
4	**48**	1219	1245	1270	1295	1321	1346	1372	1397	1422	1448	1473	1499	1524
5	**60**	1524	1549	1575	1600	1626	1651	1676	1702	1727	1753	1778	1803	1829
6	**72**	1829	1854	1880	1905	1930	1956	1981	2007	2032	2057	2083	2108	2134
7	**84**	2134	2159	2184	2210	2235	2261	2286	2311	2337	2362	2388	2413	2438
8	**96**	2438	2464	2489	2515	2540	2565	2591	2616	2642	2667	2692	2718	2743
9	**108**	2743	2769	2794	2819	2845	2870	2896	2921	2946	2972	2997	3023	3048
10	**120**	3048	3073	3099	3124	3150	3175	3200	3226	3251	3277	3302	3327	3353
11	**132**	3353	3378	3404	3429	3454	3480	3505	3531	3556	3581	3607	3632	3658
12	**144**	3658	3683	3708	3734	3759	3785	3810	3835	3861	3886	3912	3937	3962
13	**156**	3962	3988	4013	4039	4064	4089	4115	4140	4166	4191	4216	4242	4267
14	**168**	4267	4293	4318	4343	4369	4394	4420	4445	4470	4496	4521	4547	4572
15	**180**	4572	4597	4623	4648	4674	4699	4724	4750	4775	4801	4826	4851	4877
16	**192**	4877	4902	4928	4953	4978	5004	5029	5055	5080	5105	5131	5156	5182
17	**204**	5182	5207	5232	5258	5283	5309	5334	5359	5385	5410	5436	5461	5486
18	**216**	5486	5512	5537	5563	5588	5613	5639	5664	5690	5715	5740	5766	5791
19	**228**	5791	5817	5842	5867	5893	5918	5944	5969	5994	6020	6045	6071	6096
20	**240**	6096	6121	6147	6172	6198	6223	6248	6274	6299	6325	6350	6375	6401
21	**252**	6401	6426	6452	6477	6502	6528	6553	6579	6604	6629	6655	6680	6706
22	**264**	6706	6731	6756	6782	6807	6833	6858	6883	6909	6934	6960	6985	7010
23	**276**	7010	7036	7061	7087	7112	7137	7163	7188	7214	7239	7264	7290	7315
24	**288**	7315	7341	7366	7391	7417	7442	7467	7493	7518	7545	7569	7594	7620
25	**300**	7620	7645	7671	7696	7722	7747	7772	7798	7823	7849	7874	7899	7925
26	**312**	7925	7950	7975	8001	8026	8052	8077	8102	8128	8153	8179	8204	8230
27	**324**	8230	8255	8280	8306	8332	8357	8382	8408	8433	8458	8484	8509	8534
28	**336**	8534	8559	8585	8610	8636	8661	8686	8712	8737	8763	8788	8814	8839
29	**348**	8839	8864	8890	8915	8941	8966	8991	9017	9042	9068	9093	9118	9144
30	**360**	9144	9169	9195	9220	9246	9271	9296	9322	9347	9373	9398	9423	9449
31	**372**	9449	9474	9500	9525	9551	9576	9601	9627	9652	9677	9703	9728	9753
32	**384**	9754	9779	9804	9830	9855	9881	9906	9931	9957	9982	10008	10033	10058
33	**396**	10058	10083	10109	10134	10160	10185	10210	10236	10261	10287	10312	10337	10363
34	**408**	10363	10388	10414	10439	10465	10490	10515	10541	10566	10592	10617	10642	10668
35	**420**	10668	10693	10719	10744	10770	10795	10820	10846	10871	10897	10922	10947	10973
36	**432**	10973	10998	11024	11049	11075	11100	11125	11151	11176	11202	11227	11252	11278
37	**444**	11278	11303	11328	11354	11379	11405	11430	11455	11481	11506	11532	11557	11582
38	**456**	11582	11607	11633	11658	11684	11709	11734	11760	11785	11811	11836	11861	11887
39	**468**	11887	11912	11938	11963	11989	12014	12039	12065	12090	12116	12141	12166	12192
40	**480**	12192	12217	12243	12268	12294	12319	12344	12370	12395	12421	12446	12471	12497
41	**492**	12497	12522	12548	12573	12598	12624	12649	12675	12700	12725	12751	12776	12802
42	**504**	12802	12827	12852	12878	12903	12929	12954	12979	13005	13030	13056	13081	13106
43	**516**	13106	13132	13157	13183	13208	13233	13259	13284	13310	13335	13360	13386	13411
44	**528**	13411	13437	13462	13487	13513	13538	13564	13589	13614	13640	13665	13691	13716
45	**540**	13716	13741	13767	13792	13818	13843	13868	13894	13919	13945	13970	13995	14021
46	**552**	14021	14046	14072	14097	14122	14148	14173	14199	14224	14249	14275	14300	14326
47	**564**	14326	14351	14376	14402	14427	14453	14478	14503	14529	14554	14580	14605	14630
48	**576**	14630	14656	14681	14707	14732	14757	14783	14808	14834	14859	14884	14910	14935
49	**588**	14935	14961	14986	15011	15037	15062	15088	15113	15138	15164	15189	15215	15240
50	**600**	15240	15265	15291	15316	15342	15367	15392	15418	15443	15469	15494	15519	15545
51	**612**	15545	15570	15596	15621	15646	15672	15697	15723	15748	15773	15799	15824	15850
52	**624**	15850	15875	15900	15926	15951	15977	16002	16027	16053	16078	16104	16129	16154
53	**636**	16154	16180	16205	16231	16256	16281	16307	16332	16358	16383	16408	16434	16459
54	**648**	16459	16485	16510	16535	16561	16586	16612	16637	16662	16688	16713	16739	16764
	in	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"

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