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BBA BRITISH BOARD OF AGRÉMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

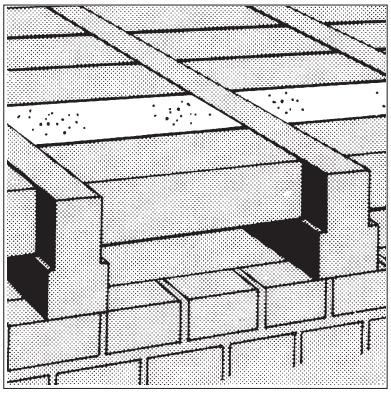
Rackham Housefloors Ltd

RACKHAM HOUSEFLOORS TYPE 225 PRE-STRESSED CONCRETE JOISTS

Certificate No 85/1566

DETAIL SHEET 5

Product



- *THIS DETAIL SHEET RELATES TO RACKHAM HOUSEFLOORS PRE-STRESSED CONCRETE FLOOR JOISTS, TYPE 225, AND THE CODE OF PRACTICE OF THE CERTIFICATE HOLDER COVERING THE SPECIFICATION OF CONCRETE INFILL BLOCKS AND FLOOR FINISHES TO BE USED WITH THE JOISTS AND THE INSTALLATION PROCEDURES FOR JOISTS, INFILL BLOCKS AND FLOOR FINISHES.*
- *The product is for use in:*

(a) suspended ground floors in dwellings or first floors in single occupancy dwellings, in conjunction with solid concrete infill blocks with screed, polystyrene/chipboard or mastic asphalt floor finishes

(b) domestic garage floors, in conjunction with 7.0 Nmm^{-2} solid concrete infill blocks with reinforced screed finishes

(c) compartment and separating floors in dwellings, in conjunction with solid concrete infill blocks with a minimum density of 2000 kgm^{-3} and resilient and floating layers or an appropriate dense screed and a soft covering

(d) suspended ground and first floors in commercial and light industrial buildings (for superimposed distributed loads up to 5.0 kNm^{-2}) in conjunction with 7.0 Nmm^{-2} solid concrete infill blocks with screed finishes.

This Detail Sheet must be read in conjunction with Detail Sheet 1, which gives the product's position regarding the Building Regulations and Conditions of Certification.

Technical Specification

1 Description

1.1 The Rackham Housefloors Type 225 joist is a pre-stressed concrete floor joist (see Figure 1), for use with solid concrete infill blocks in accordance with the company's code of practice to form suspended floors. The code of practice (see Figure 2) includes design criteria, typical installation details, handling requirements for the concrete infill blocks and the installation requirements for screed and chipboard/polystyrene floor finishes.

1.2 The joists are designed in accordance with BS 8110 : Parts 1 and 2 : 1985.

1.3 The joists have an overall depth of 225 mm and are pre-stressed by seven 5 mm diameter indented steel wires, to BS 5896 : 1980, with a minimum tensile strength of 1670 Nmm^{-2} (see Figure 1).

Figure 1 Joist cross-section

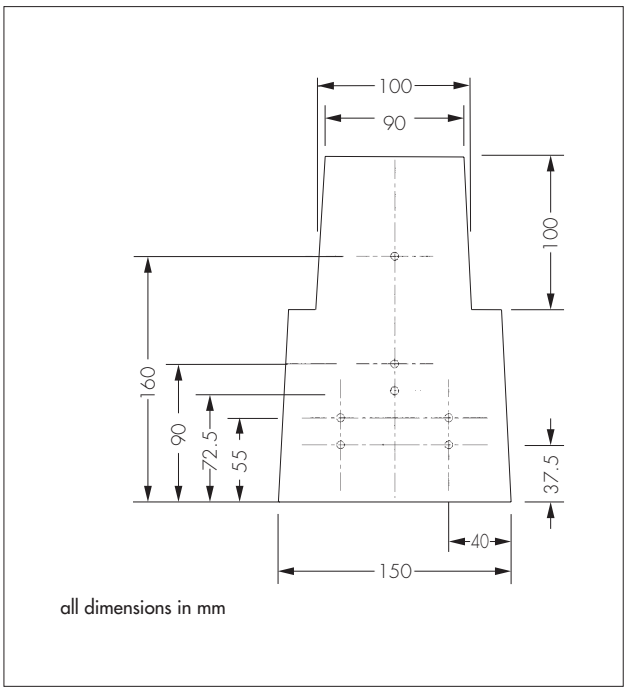
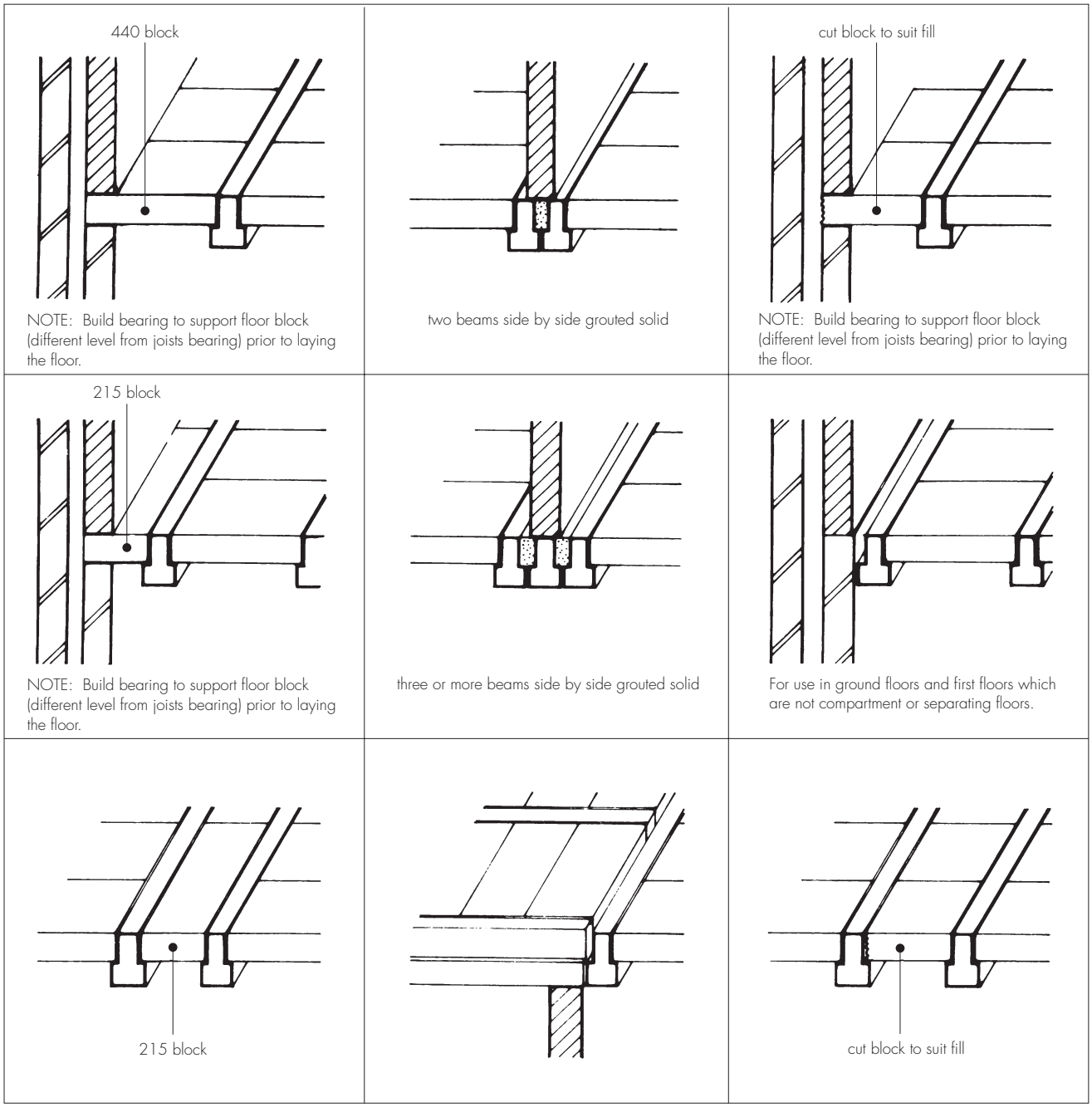


Figure 2 Typical details



1.4 The concrete has a minimum compressive strength of 60 Nmm^{-2} at 28 days and is made with Portland cement, class 52.5, complying with BS 12 : 1991, and aggregates in accordance with BS 882 : 1983.

1.5 The joists are made by casting the concrete around the pre-stressing wires in long steel moulds, with individual joists separated by polystyrene inserts. The wires are pre-tensioned over the full length of the mould and supported in position at intervals. When the concrete has achieved adequate strength the pre-stressing wires are de-tensioned and cut, and the joists removed from the moulds.

1.6 Quality control on the joists includes checks on:

quality of the materials
mix proportions
position of pre-stressing wires prior to casting
cover to pre-stressing wires after casting
concrete strength
visual appearance
dimensional accuracy
stiffness and strength of the finished joists.

2 Delivery and site handling

2.1 The joists are delivered to site stacked and supported on timber bearers.

2.2 Care must be taken in unloading, stacking and storing the joists to prevent damage. Joists should be lifted at points as near as possible to each end, ensuring that they remain the correct way up at all times. On site, joists must be stored clear of the ground and, if stacked, timber bearers should be placed near the ends to separate them. The joists and bearers should be stacked vertically one above the other.

2.3 It is not necessary to protect the joists from the weather provided exposure will not exceed three months. In the event of longer periods, they should be stored under cover.

Design Data

3 General

3.1 Rackham Housefloors Type 225 Pre-stressed Concrete Joists are suitable for use as floor joists in ground and intermediate floors when used in accordance with this Detail Sheet.

3.2 Rackham Housefloors Ltd's code of practice concerning the specification and use with the joists of concrete infill blocks, screed, chipboard/ insulation or mastic asphalt floor finishes have been assessed as suitable in providing satisfactory floors for the uses listed in the *Product* part of this Detail Sheet.

4 Structural performance

4.1 Allowable spans for floors incorporating Type 225 joists based on deflection, ultimate or serviceability requirements for a Class 3 structure with a theoretical crack width of 0.1 mm should be determined in accordance with BS 8110 : Part 1 : 1985, Section 4, using the joist parameters given in Table 1. The joists should be assumed to be simply-supported and no account should be taken of any composite action between the joists and infill blocks or finishes.

Table 1 Joist parameters

Parameter	Value
Service moment of resistance M_R (kNm)	14.71
Ultimate moment of resistance M_u (kNm)	20.79
Ultimate shear resistance (uncracked in flexure) V_{co} (kN)	36.75
Design effective prestress in tendons after all losses fpe (Nmm^{-2})	918
Moment necessary to produce zero stress in concrete at the extreme tension fibre M_o (kNm)	11.72

4.2 The dead load of the floor must include the weight of the joists, infill blocks, grouting between the joists and both floor and ceiling finishes if appropriate (see section 4.3). Imposed loadings, distributed and point, should be taken from BS 6399 : Part 1 : 1984 (eg in domestic dwellings the uniform distributed load should be taken as 1.5 kNm^{-2} and the point load as 1.4 kN) unless the actual loads are known and exceed those given.

4.3 The construction of compartment or separating floors has to satisfy the relevant Building Regulations requirements to resist the transmission of airborne sound. If this is achieved by using a superficial mass recommendation, the maximum clear span should be determined for an appropriate construction giving the required mass (see section 9).

4.4 The bearing width of the joists must be determined in accordance with BS 8110 : Part 1 : 1985 or BS 5628 : Part 3 : 1985. For example, in dwellings with joists less than 5 metres long the minimum nominal bearing should be 85 mm when supported on brickwork or masonry, and 55 mm when supported on steel. Support walls must be designed to carry the full dead and imposed loading.

4.5 Joists installed in the configurations shown in Figure 3 have adequate strength and stiffness to sustain the superimposed distributed loads over the spans given in Table 2. Maximum spans over which the joists are capable of supporting other loadings are available from Rackham Housefloors Ltd. These should be confirmed in accordance with sections 4.1 and 4.2. The spans in Table 2 have been determined for a floor finish of 1.2 kNm^{-2} in accordance with section 4.1, and:

(a) the joists under the specified loadings satisfy the requirements for serviceability limit states of deflection given in BS 8110 : Part 2 : 1985, Section 3.2.1, for:

deflection below level of supports

$$< \frac{span}{250}$$

and for damage to non-structural elements (non-brittle partitions or finishes)

$$< \frac{span}{350}$$ or 20 mm, whichever is the lesser,

after installation of each partition and finishes (assuming that the full imposed loads are not applied until one month after casting of the joists and that 25% of the live load is considered permanent).

Note: Joists supporting blockwork walls will exhibit long-term creep deflections which may cause minor cracking at doors and other openings.

(b) Where two or more joists are placed side by side it is assumed that the spaces above the flanges are filled with grout to ensure unity of action and loads are shared equally between them.

Figure 3 Nomenclature of standard cases

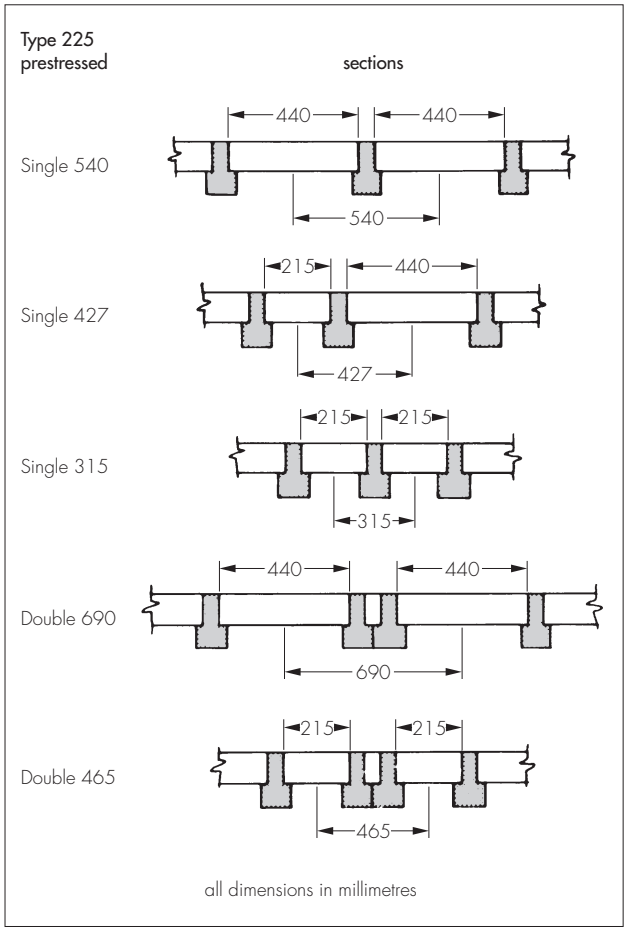


Table 2 Maximum effective clear spans (metres)

Block dry density (kgm^{-3})	Standard centres	Superimposed distributed load (kNm^{-2})			
		1.5	2.5	4.0	5.0
650	S540	6.76	6.05	5.30	4.93
	S315	8.19	7.44	6.62	6.21
	S427	7.38	6.64	5.86	5.47
	D690	7.88	7.15	6.36	5.95
	D465	8.90	8.18	7.37	6.94
1325	S540	6.39	5.78	5.12	4.79
	S315	7.87	7.20	6.45	6.06
	S427	7.02	6.38	5.68	5.32
	D690	7.59	6.93	6.20	5.82
	D465	8.69	8.02	7.25	6.84
2000	S540	6.08	5.55	4.95	4.65
	S315	7.58	6.98	6.29	5.93
	S427	6.71	6.14	5.51	5.18
	D690	7.32	6.72	6.05	5.70
	D465	8.49	7.86	7.13	6.74

5 Behaviour in relation to fire

5.1 The joists are non-combustible and the surfaces of the joists are classified as:

(a) Class 0 as defined in the appropriate supporting document to the national Building Regulations:

England and Wales

Approved Document B, Appendix A.

Scotland

Technical Standards, Appendix to Part D.

Northern Ireland

Technical Booklet E, Section 2.

(b) Class 1 as defined in BS 476 : Part 7 : 1971.

5.2 When assessed according to BS 8110 : Part 2 : 1985 the joists have a fire resistance of one hour. The fire resistance of floors constructed using the joists will be an hour or better depending upon the soffit finish, if any, used.

6 Condensation risk

6.1 The risk of condensation in ground floors constructed using the joists will be dependent on the type of infill blocks used, the moisture permeability of floor finish and the temperature and relative humidity above the floor.

6.2 In ground floors constructed in accordance with the company's code of practice using the joists, infill blocks and the specified finishes over a ventilated void, the likely condensation risk with the finishes over infill blocks with densities shown, is:

Chipboard on a vapour barrier on expanded polystyrene

- 1800 kgm^{-3} and below — the risk of condensation will be very low provided attention is paid to good jointing of the vapour barrier (ie 0.25 mm thick polythene sheets must have 150 mm taped laps or 300 mm loose laps and should be carried up 100 mm at the perimeter and at pipes penetrating through the floor)
- greater than 1800 kgm^{-3} and when joists are placed adjacent to each other without blocks — the relative humidity above the floor must be kept generally below 65% to avoid condensation.

Cement/sand screed finish

- 1000 kgm^{-3} and below — condensation is unlikely to occur
- 1000 kgm^{-3} to 1275 kgm^{-3} — condensation is unlikely to be a problem unless an impermeable floor covering, eg vinyl tiles, is used in areas which are subsequently carpeted
- 1275 kgm^{-3} to 1800 kgm^{-3} — transient condensation may occur in some extreme circumstances and impermeable floor coverings should not be used
- greater than 1800 kgm^{-3} and when joists are placed adjacent to each other without blocks — the relative humidity above the floor must be kept generally below 65% to avoid condensation.

Mastic asphalt finish

- 1000 kgm^{-3} and below — condensation is unlikely to occur except in some extreme circumstances
- greater than 1000 kgm^{-3} and when joists are placed adjacent to each other without blocks — provided the relative humidity is kept generally below 65% transient condensation will only occur in extreme circumstances.

7 Thermal transmittance

7.1 The thermal performance of ground floors constructed using the joists will be dependent on the type of infill blocks used, the floor finish and the area of the floor.

7.2 The thermal transmittance (U value) for ground floors constructed in accordance with the Certificate holder's code of practice was calculated for three typical floor areas for floor configurations with single joists separated by blocks on the 440 mm dimension. The values are given in Table 3, they were determined in accordance with the Building Regulations, Approved Document L, Appendix C (England and Wales) and the Technical Standards, Part J, Appendix F (Scotland) using the thermal conductivity (λ value) data given in Table 4 obtained from CIBSE Guide A3.

Table 3 Thermal transmittance (U value) of typical ground floors (Wm^{-2}K^{-1})

Floor finish	Infill block dry density (kgm^{-3})	Floor area (m × m)		
		10 × 4	10 × 6	10 × 10
50 mm lightweight screed	650	0.62	0.54	0.47
	1325	0.70	0.61	0.51
	2000	0.76	0.65	0.54
18 mm chipboard on 50 mm of insulation	650	0.34	0.31	0.28
	1325	0.36	0.34	0.31
	2000	0.38	0.35	0.32

Table 4 Thermal conductivity values

Component	λ value (Wm^{-1}K^{-1})
dense concrete of the joists	1.83[1]
650 kgm^{-3} infill blocks	0.20[1]
1325 kgm^{-3} infill blocks	0.46[1]
2000 kgm^{-3} infill blocks	1.13[1]
lightweight screed of density 1200 kgm^{-3}	0.38[1]
insulation	0.038
chipboard	0.14

(1) Derived from the Jakob curve corresponding to 3% standard moisture content.

8 Practicability of installation

The joists can be handled easily by methods commonly used in building practice. Longer joists can be placed in approximate position by mechanical means and then manhandled into final position.

9 Sound

9.1 Each joist will contribute an equivalent mass of 67.8 kg per metre length to the floor construction. The effective contribution to the overall floor construction will be dependent on the joist configurations used. The performance of the floor will also be dependent on the type of infill blocks and the floor finish used.

9.2 Where Type 225 joists are used in configuration S540 with a joist spacing of 540 mm, a floor incorporating blocks of minimum density 2000 kgm^{-3} will have an equivalent mass greater than 300 kgm^{-2} and will provide a concrete base that can accept resilient and floating layers (screed or timber raft) in accordance with the appropriate supporting documents to the relevant national Building Regulations:

England and Wales

Approved Document E, Section 2, Floor type 2.

Scotland

Technical Standards, Part H, of *Provisions deemed to satisfy the standard,* Section 15, Floor type 2.

Northern Ireland

Technical Booklet G, Section 1.10, Floor type 2.

9.3 With the addition of 50 mm screed with a minimum density 1300 kgm^{-3} the floor will have an equivalent mass greater than 365 kgm^{-2} and will provide a concrete base that can accept a soft covering in accordance with the appropriate supporting documents to the relevant national Building Regulations:

England and Wales

Approved Document E, Section 2, Floor type 1.

Scotland

Technical Standards, Part H, *Provisions deemed to* satisfy *the standards,* Section 15, Floor type 1.

Northern Ireland

Technical Booklet G, Section 1.10, Floor type 1.

9.4 Floors constructed in accordance with sections 9.2 or 9.3 will provide adequate resistance to the passage of sound when used with appropriate flanking constructions.

10 Durability

The exposure condition beneath a suspended ground floor over a ventilated void and soil with no oversite concrete or other surface seal is considered to be 'moderate' in accordance with BS 8110 : Part 1 : 1985 (Table 3.2). The joists will have adequate durability for these exposure conditions provided they are used in accordance with this Certificate.

Installation

11 Site preparation

11.1 The ground beneath the floor must be cleared of any surface soil and vegetable matter and the solum treated to prevent vegetable growth. No oversite concrete or other surface seal is required, but material added to bring the solum to an even surface should be hard and dry.

11.2 Damp-proofing and ventilation arrangements must be in accordance with normal good practice, for example, provision of damp-proof sleeves to ventilators and adequate drainage of the sub-floor.

11.3 A continuous damp-proof course should be laid along the support wall below the floor in accordance with CP 102 : 1973.

11.4 A void at least 75 mm deep must be provided between the underside of the floor and the ground surface. With heavy clay soil, the depth should be increased to 150 mm to prevent problems associated with heave. With good natural drainage or site drains provided to prevent water collecting and standing, the ground level beneath the floor does not need to be raised to the external ground level but where the levels differ the ability of the perimeter walls to act as retaining walls must be checked.

11.5 In Scotland it is considered good practice for the solum area beneath all suspended floors to be brought up to at least the level of the adjoining ground, except where an arrangement of damp-proof membranes or damp-proof courses is installed to prevent the ingress of ground water to the solum set at a lower level.

11.6 Ventilation must be provided to the void beneath the floor by openings in all the external walls at not more than 3 metre centres to give a minimum open area per metre run of wall of 600 mm^2. In areas where there might be landfill gas or methane contamination the recommended minimum area of opening(1), of 1500 mm^2 per metre run of wall or 500 mm^2 per square metre of floor area, whichever is the greater, should be used. In areas where full radon precautions are required the minimum open area of 1500 mm^2 per metre run(2) should be used and provision made for possible later addition of mechanical ventilation.

(1) From the BRE Guidance Document *Construction of new buildings on gas contaminated land.*

(2) See BRE Guidance Document *Radon : guidance on protective measures for new dwellings*

12 Floor installation

12.1 Some typical installation details are shown in Figure 2.

12.2 Bearings must be in accordance with section 4.4, and level and clear of debris.

12.3 For masonry cavity wall construction the minimum bearing (see section 4.4 of the relevant Detail Sheet) should be provided on the inner leaf, and joists must not project into the cavity. Careful setting-out will be required when joists are built into cavity walls at either end.

12.4 Any operation likely to impair the durability or strength of the joists (for example, drilling to attach services or cutting) should not be undertaken without authorisation from Rackham Housefloors Ltd.

12.5 To comply with the Certificate holder's code of practice, the joists must be used with either blocks covered by a valid BBA Certificate for use as floor infill blocks and used with the finishes detailed in, and for the building classes given in that Certificate, or blocks approved by Rackham Housefloors Ltd to the following specification:

Solid concrete building blocks of nominal dimensions 440 by 215 by 100 mm, minimum compressive strength 3.5 Nmm^{-2} (minimum 7.0 Nmm^{-2} for domestic garages, commercial and light industrial buildings) and manufactured in accordance with BS 6073 : Part 1 : 1981. As with other joist and block floors, the blocks must have adequate strength. For use with the joists, the blocks, when simply-supported over a 420 mm span, must be capable of sustaining a transverse load of 3.5 kN or the relevant concentrated load given in BS 6399 : Part 1 : 1984 with a load factor in excess of 2.5 or the known maximum concentrated load, whichever is greater.

12.6 Infill blocks should be placed between the ends of the joists to ensure correct spacing. The blocks must be provided with adequate bearing by clearing the joist flanges of debris and ensuring adjacent blocks are abutted as close as possible. If blocks are cut or drilled, the structural performance must not be impaired.

12.7 Where two or more joists are placed side by side, the space between them, above the flanges, must be filled with in-situ concrete of minimum compressive strength 30 Nmm^{-2} and 40 mm maximum sized aggregate. The concrete must be allowed to cure to the necessary strength before loads, such as partition walls, are applied.

12.8 A cement/sand grout must be well brushed over all the floor to fill all voids between blocks and joists. The floor must be thoroughly cleaned before application of the finish.

12.9 Care must be taken to avoid overloading the floor during construction. Planks should be laid across the joists before stacking materials as close as possible to the floor bearings. During construction the floor should only be used for short-term material storage and construction traffic.

13 Floor finishes

13.1 The following finishes, for use on ground and first floors, are covered by Rackham Housefloors Ltd's code of practice and are the finishes referred to in section 6.

Screed

13.2 A 50 mm minimum thick lightweight cement/sand screed in accordance with BS 8204 : Part 1 : 1987, and BS 8204 : Part 2 : 1987, can be laid directly on the grouted floor and, unless it is to be particularly moisture sensitive (as described in BS CP 102 : 1973), a damp-proof membrane need not be laid over a ground floor. In areas where there might be landfill gas or methane and areas where full radon precautions are required, a gas-proof barrier must be used. Full details are given in BRE Guidance Documents (see footnotes to section 11.6). The membrane across the main floor area must be continuous with a cavity tray in the surround wall to form a complete gas-proof barrier. For compartment or separating floors the thickness and/or density of the screed may need to be increased to provide a concrete base that can accept a floating layer or soft covering in accordance with the appropriate supporting document to the relevant national Building Regulations (see sections 4.3 and 9).

Screed for domestic garages

13.3 For use in domestic garage floors, the screed should be a minimum 50 mm thick concrete of minimum compressive strength 20 Nmm^{-2} and reinforced with A98 steel mesh reinforcement to BS 4483 : 1985.

Chipboard/insulation — for use on ground floors

13.4 Chipboard/insulation floor finish are either:

- Tongue-and-groove chipboard type C4, 18 mm thick, to BS 5669 : Part 2 : 1989, laid with staggered cross-joints on a vapour control layer on an appropriate floor insulation the subject of a current BBA Certificate and laid in accordance with that Certificate, or
- a laminated chipboard/insulation floor covering, the subject of a current BBA Certificate laid in accordance with that Certificate.

13.5 Any vapour control layer used should be laid between the insulation and chipboard, it should consist of 0.25 mm thick (1000 gauge) polythene with 150 mm overlapped and taped joints and 100 mm turned up at the walls (see section 13.2).

13.6 Floors constructed using joists and infill blocks complying with the company's code of practice should be flat enough to accept the above coverings without the need for screeding or other finishing.

Mastic asphalt

13.7 A 15 mm thick mastic asphalt floor finish laid in accordance with CP 204 : Part 2 : 1970, BS 6925 :1988 and BS 6577 : 1985 can be laid directly on the grouted floor and, unless it is to be particularly moisture sensitive (as described in CP 102 : 1973), a damp-proof course need not be laid over a ground floor (see section 6).

14 Incorporation of services

14.1 Services must not be attached to joists or blocks in such a way as to impair their durability or strength.

14.2 Vertical services passing through floors must be wrapped in flexible materials or ducted, and any vapour barrier they pass through sealed.

14.3 In areas subject to landfill gas or methane and areas where full radon precautions are required, services should not pass through the floor if this is avoidable. Where this is unavoidable the services should be sealed against the gas-proof barrier as detailed in the BRE Guidance Documents *Construction of new buildings on gas contaminated land* and *Radon : guidance on protective measures for new dwellings*.

14.4 Vertical service pipes (other than gas pipes) passing through compartment or separating floors should be wrapped for their full height with at least 25 mm of mineral fibre and ducted both above and below the floor, the duct being cased with board material weighing at least 15 kgm^{-2} and sealed to prevent air leaks in accordance with the appropriate supporting documents to the relevant national Building Regulations:

England and Wales

Approved Document E, Section 2.

Scotland

Technical Standards, Part H, *Provisions deemed to satisfy the standards,* Section 14 or 15.

Northern Ireland

Technical Booklet G, Section 1.9 or 1.10.

14.5 Blocks must not be cut to accommodate horizontal services. Horizontal services may be installed within the floor finishes where possible.

14.6 Water pipes must be pre-lagged.

Screeds and mastic asphalt

14.7 Provision must be made to prevent subsequent damage due to differential movement between the floors and services, for example, wrapping in flexible materials.

Chipboard/insulation

14.8 Expanded polystyrene insulations (maximum continuous working temperature of 80°C) must be cut back from hot water pipes to maintain an air space, and prevented from contacting electrical cables by enclosing the cables in suitable conduit.

Technical Investigations

The following is a summary of the technical investigations carried out on Rackham Housefloors Type 225 Pre-stressed Concrete Joists and floors constructed using the joists in accordance with the company's code of practice.

15 Investigations

15.1 The structural calculations for the joist designs and the submitted load/span tables were verified in accordance with BS 8110 : Part 1 : 1985.

15.2 The results of tests on various makes of infill blocks subjected to static and impact loads were examined.

15.3 Existing data relating to the durability of the joists and components referred to in the company's code of practice, when used within the scope of the Certificate, were examined. It was concluded that the components (ie chipboard, approved insulations, mastic asphalt, polythene vapour barrier, concrete infill blocks and cement/sand screed) are standard building materials and will have a durability compatible with that of the joists.

15.4 An assessment was made of the practicability of installation including laying the joists, installing the infill blocks and applying the finishes. It was found that the joists could be easily laid, installation of the infill blocks could be rapidly carried out and the finishes easily applied.

15.5 The manufacturing processes for the joists were examined, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

Bibliography

BS 4483 : 1985 *Specification for steel fabric for the reinforcement of concrete*

BS 5268 : Part 5 : 1989 *Structural use of timber — Code of practice for the preservative treatments for constructional timber*

BS 5669 : Part 2 : 1989 *Specification for wood chipboard*

BS 6073 : Part 1 : 1981 *Specification for precast concrete masonry units*

BS 6399 : Part 1 : 1984 *Code of practice for dead and imposed loads*

BS 8110 : Part 1 : 1997 *Code of practice for design and construction*
Part 2 : 1985 *Code of practice for special circumstances*

BS 8204 *In-situ floorings*
Part 1 : 1987 *Code of practice for concrete bases and screed to receive in-situ floorings*
Part 2 : 1987 *Code of practice for concrete wearing surfaces*

CP 102 : 1973 *Code of practice for protection of buildings from water from the ground*

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On behalf of the British Board of Agrément

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