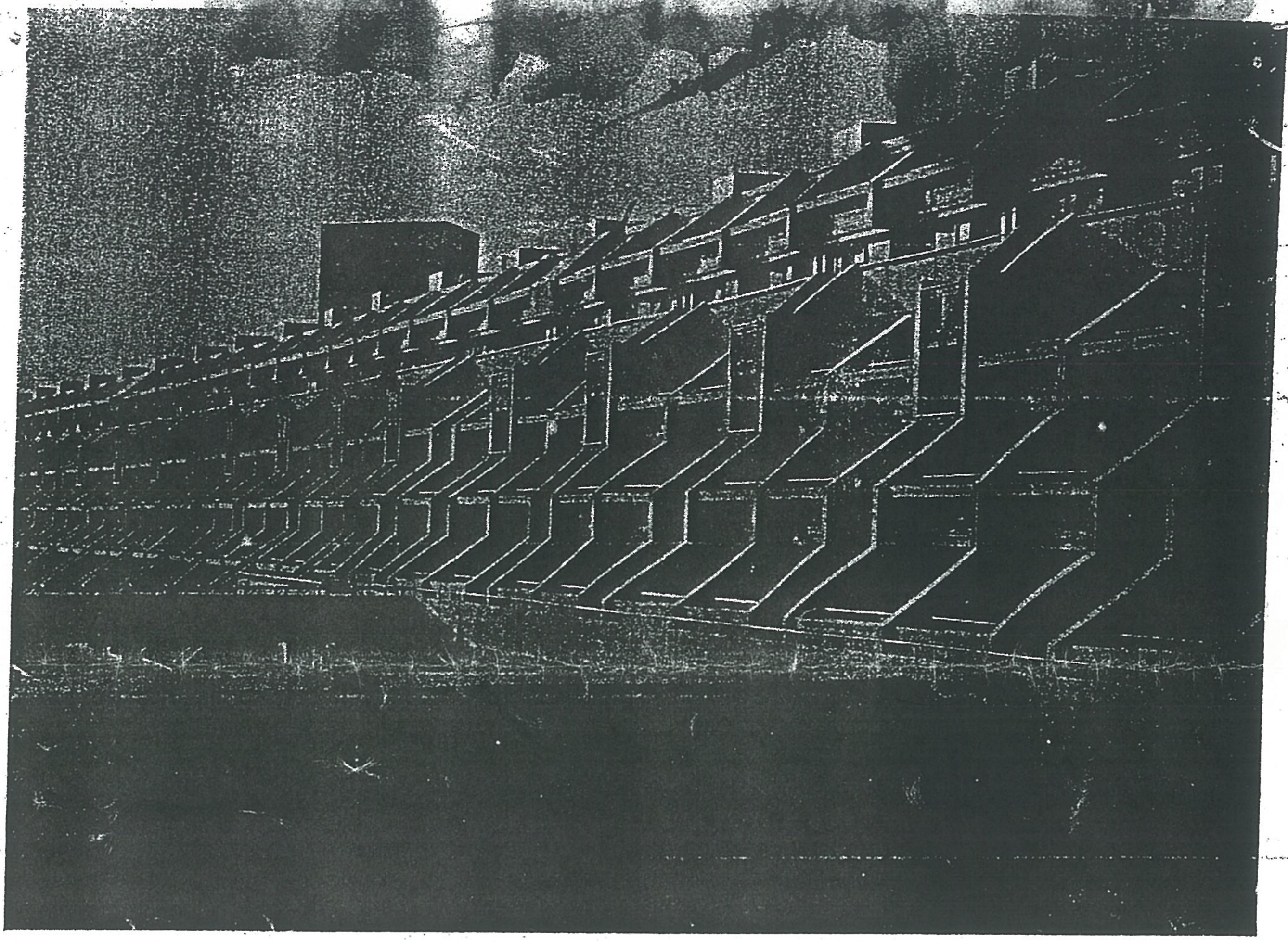

RADIANT WALL HEATING FOR FLATS

by Max Fordham, MA, FCIBS* and Helen Ryding BSc, MCIBE

The plans of the flats at Alexandra Road present a special heating problem since few windows had a high cill and the Architect wanted to avoid radiators obstructing the wall surfaces. Compact radiator systems to meet this brief were designed and costed. The alternative of a conventional panel heating system in the floor finish was discarded by the Design Team as being too expensive. A panel system with pipe coils cast into the centre of the concrete floors seemed attractive since it met the design requirement and initial checks suggested it was not too expensive.

Alexandra Road, London NW8 is a high density redevelopment scheme for the London Borough of Camden. It comprises 520 flats, maisonettes and houses, a Special School, a Childrens' Reception Home, a Physically Handicapped Home, a Youth Club, a Building Department Depot as well as a Community Centre, district heating boilerhouse and a public park.

The housing is heated by steel pipe coils cast into concrete tenancy separating walls, and fed by water from the district boiler house. As far as one can tell, this method of heating has not been used before on such a scale, if at all. It was devised because of the particular requirements of the building and also because of its cost advantages over equivalent radiator schemes.

In line with current thinking on controlling ventilation it has mechanical supply ventilation at the rate of 1½ air changes/h to each flat. This solution was originally suggested as part of the acoustic precaution for the long block but was extended to all dwellings after the contractor had been appointed.

Design Brief

Initially, the heating coils were to be used only in one particular block of flats on the site, and the other blocks were to be heated by radiators. This particular block consists of a seven storey slab block, approximately a quarter of a mile long, of identical cross-section along its length (with minor variations at the lowest level), with three different flat or maisonette plans. The block is designed to act as a noise barrier for the rest of the site (the site is bounded by the main line from Euston), and has special acoustic precautions along its back wall.

The design had to meet three main criteria:

(1) The architectural layout with floor to ceiling glazing, meant that suitable radiator postions were difficult

above:
Fig 1—Part of the flats at Alexandra Road

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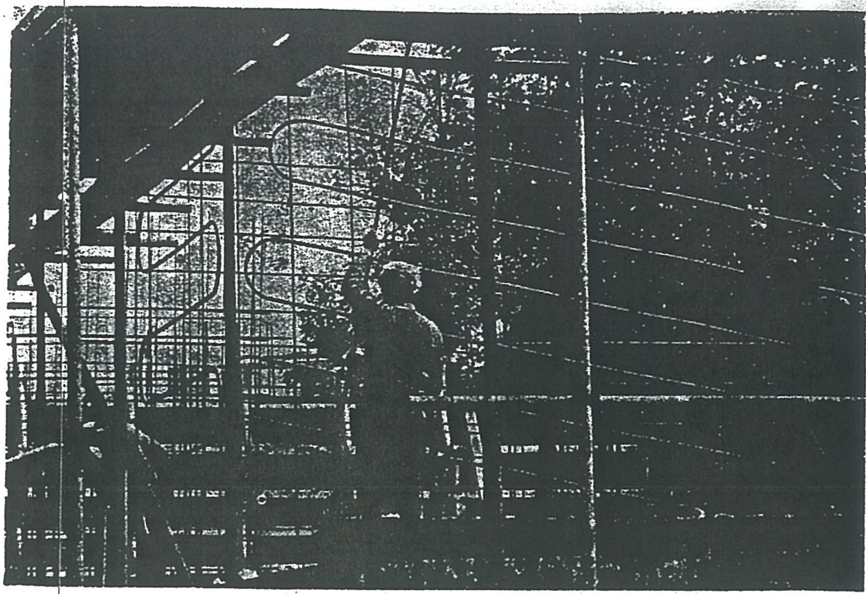
*Max Fordham & Partners, Consulting Engineers.

Fig 2. — Installing the heating coils on site



to find without obstructing the walls, which the architect wished to avoid in order to avoid the obstruction caused to furniture positions.

(2) The brief from the Housing Manager was to design a form of heating which would avoid the likelihood of condensation in dwellings, by being cheap to run. Initially, it was felt acceptable to sacrifice some measure of individual tenant control in order to maintain background heating at all times. (Later this was retracted, and full tenant control was called for.) Later some measure of tenant control was called for and provided.

(3) The soundproofing precautions along the back wall of the building included double glazing, which is intended to be kept closed. This problem and rulings by the District Surveyor in relation to the setback section of the building required the provision of mechanical ventilation to the rooms at the back of the building. This requirement became known after the preliminary design for the heating system had been done.

Reasons for Choosing Scheme

The alternatives considered were: a radiator system using low radiators built into recesses under windows, or running along skirtings; or conventional underfloor panel heating in the screed. Underfloor electric heating was rejected as being too expensive to run. Pipe coils in the screed proved to be more expensive, but led to the investigation of pipe coils cast into the structural floor or walls. This proved to be cheaper but the structural implications of floor panels, necessitated expensive expansion joints every four dwellings. This was avoided by putting the coils in the cross-walls, with the extra advantage that the upper limits to the surface temperature for comfort conditions were higher, and thus a greater output of heat could be achieved. On consideration of the heat losses and which walls to heat, it became clear that satisfactory conditions could be achieved by heating only alternate cross walls. Detailed investigations were then made, which proved satisfactory. Costs, despite modifications to the structure, were still considerably lower than the radiator scheme.

The needs for full tenant control and for mechanical ventilation became known at about the same time. This problem was solved by designing a small fan and heater battery in their own purpose made casing, to be fitted in each dwelling. The heater battery has a bypass damper so that the incoming fresh air can be either hot or cold, providing control of the heating system for the tenant and satisfying the mechanical ventilation requirement.

The two other housing blocks originally were of concrete block cross wall construction, with radiator heating. Following the request of the contractor to change these two housing blocks to *in situ* concrete construction it was decided to change the heating scheme to pipe coils as well. In these two blocks, the dwelling plans necessitated more wall heating, and in the block of houses, both cross walls are heated. These blocks do not have a mechanical ventilation requirement, but the fan convector units have been retained to provide tenant control. This extra cost was set against the saving in changing to pipe coils, and also a saving in changing to concrete construction.

Investigations of Similar Schemes

Our investigations, and those of BSRIA, produced some theoretical information on wall panel heating, but no information on actual calculations. The wall panels mentioned were usually pipes embedded in plaster. However, considerable practical experience of floor panel heating was provided by Balency Schuhl, a French firm of consulting engineers, who have been responsible for the design and construction of several thousands of dwellings with pipes cast into structural concrete floors. These dwellings have mostly been tower blocks in France, but recently they have collaborated with G. N. Haden on a large housing scheme at Ballymun, in Ireland. A questionnaire was sent to several of the French architects involved. This revealed that there were not problems with cracking concrete or corrosion of the coils, except in one case where the contractor had used accelerators in the concrete. The heating was satisfactory unless water temperatures over 45°C were used, in which case, the tenants tended to complain about the floor temperature affecting their feet. Occasional problems of comfort arose where heating was uneven due to the coil layout not being diffuse enough. In most cases, the circulated water had some form of treatment.

We have based most of the installation procedures on the experience of these French schemes.

Concrete Design

The heated walls are built from concrete containing limestone aggregate. This was chosen by the structural engineer in consultation with the Cement and Concrete Association to reduce the amount of expansion of the walls. Extra reinforcement was necessary to control tension caused by the increased temperature at the centre of the wall, and also to control shrinkage cracks. Gable ends of each block are cast in two panels, separated by an expansion joint to allow for movement of the inner panel containing the heating coil, and also to provide insulation.

Allowance must be made in the thickness of the wall for adequate vibration of the wall, bearing in mind the pipe coil, extra reinforcing steel, and conduits. The reinforcement was formed in two layers instead of one in the centre plane of the wall.

Supply of Heat

Each block, (a quarter of a mile long) is served by three heating mains running in roof ducts or exposed in garages. A weather-compensated flow main provides heating water at flow temperatures ranging between 82 and 60°C for the

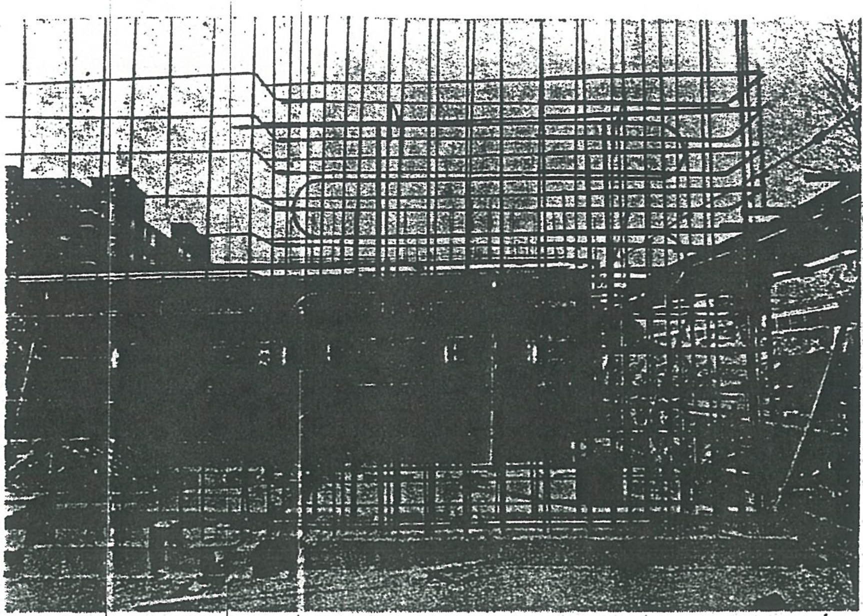


Fig 3 — Steel pipe coils in position before casting the concrete

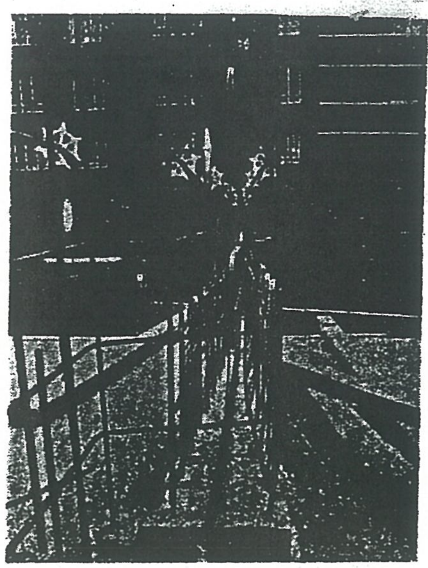


Fig 4 — Close-up of a steel pipe coil

pipe coils, a constant temperature flow main at 115°C provides a primary supply to each dwelling's individual indirect cylinder, and a third pipe provides a joint return for both these systems. Heat is provided by three oil-fired (35 sec gas oil) boilers in the boilerhouse for the site.

Vertical risers for paired stacks of dwellings feed the coils and fan convector units. Water is first fed through the fan convectors and then through the coils. Each pipe coils is valved off from the riser. All pipework in this section is standard steel pipework with screwed joints.

Installation

The pipe coils were manufactured by a specialist manufacturer and delivered to the heating contractor. The services engineers specified that the coils should be sealed and pressurised with compressed air by the heating contractors; the main contractor then took the coils and placed them in position with the wall reinforcement. The concrete was then cast. The pressure in the coil was to be monitored to provide immediate indication if any damage occurred to the coil.

The services engineers advised that the concrete specification be written to exclude the use of additives, particularly calcium or magnesium chloride. If heat were applied to the concrete too soon after casting it could accelerate the rate of hydration and so aggravate the occurrence of shrinkage cracks in concrete and plaster. The mechanical specification limited the rate at which the coil temperature should be raised and called for the plaster to have a minimum of two weeks drying before heat was applied.

These measures should limit corrosion at the outside of the pipes especially as all heated walls are within the weatherproof skin of the building. The corrosion from inside pipes in a closed system is limited by excluding oxygen and keeping the water slightly alkaline.

Fan Convector System

The fan convector itself was a galvanised sheet steel box. The heater battery was designed to heat air to 21°C, using water at 82°C return temperature 66°C. The air quantities were chosen to give 1½ air changes throughout the dwelling and the box has one or two fans, according to the size of the dwelling. A damper is fitted so that air can either be drawn over the heater battery or bypass it for cooling. Fresh air is fed into the fan convector via an acoustic maze through builders work, designed to reduce the noise path from the railway. Each fan convector serves two or three rooms in the dwelling. The air is delivered through small metal ducts or builders work to grilles in the skirting. The fan can be switched on from each room served by it, though families will have to agree whether they all want hot or cold air.

Wall Finish

The walls are plastered and painted. The surface temperature is only 38°C, the sort of temperature encountered on chimney breasts, so no special precautions were felt necessary, apart from the procedure for warming up the coils, which should not be going on at the same time as plastering and painting. However because of the limestone aggregate in the walls, it may be necessary to specify plaster.

Antomatic Control

Control of the heating is achieved in a number of ways. The basic level of heating provided for all tenants in one block will be set by the water flow temperature, which will be controlled in the boiler house by a weather sensitive compensator, independently for each block, as is normally done for radiator systems.

It was expected that the high thermal storage of the building would prevent sensitive control according to rapidly fluctuating weather conditions. Very rough calculations gave the building a response time of about four hours (compared with 20 minutes for a pulse of water to go round the system). The Meteorological Office were consulted about rapid fluctuations. It was found that changes of 6°C or more, in less than two hours happened very rarely. Changes of 3°C in less than two hours downwards are very infrequent, but changes upwards happen about 10 times a year, usually in spring. In view of this, the need for short term weather forecasts and prewarming of the walls, in advance of a sudden cold spell, were not felt to be necessary. Sudden falls in temperature were moderate enough to be dealt with, either directly by the walls: the room temperature falling in response to the falling outside temperature, would increase the temperature difference between the wall and room air, automatically increasing the wall output by radiation and convection; or by the fan convector, which, already supplied with hotter water from the boiler house could provide an immediate response.

Sudden rises in temperature would be dealt with in the reverse way: directly by the wall output dropping in response to the reduced temperature difference between the wall and the room; and indirectly, by bringing relatively cold fresh air from outside, through the fan convector, bypassing the heater battery.

Control of the heating coils directly by the tenant, is not feasible for two reasons. In the first place the coils often serve two dwellings one on either side of the wall. In the second place, shutting off water to one coil would upset the balancing, and interfere with the heating produced by coils in other parts of the walls.

Architect: Neave Brown
Consulting Engineers: Max Fordham & Partners
Heating Contractor: Drake & Scull Engineering Ltd