2

Two building studies

This chapter analyses the structures of two very different buildings. Between them they exemplify structure enriching most aspects and areas of architecture. It prepares the way for a more detailed investigation and categorization of the architectural potential of structure in subsequent chapters.

The following two building studies illustrate the considered use of exposed structure in very different architectural contexts. First, the BRIT School, London, is considered. While it displays an exuberant exterior structure, its structure as experienced from the interior adopts a more utilitarian stance. Roles reverse in the second building, the Baumschulenweg Crematorium, with its impressive exposed interior structure. Within a formal minimalist exterior envelope, large 'randomly placed' interior columns transform the main interior space, imbuing it with feeling and meaning.

British Record Industry Trust (BRIT) School

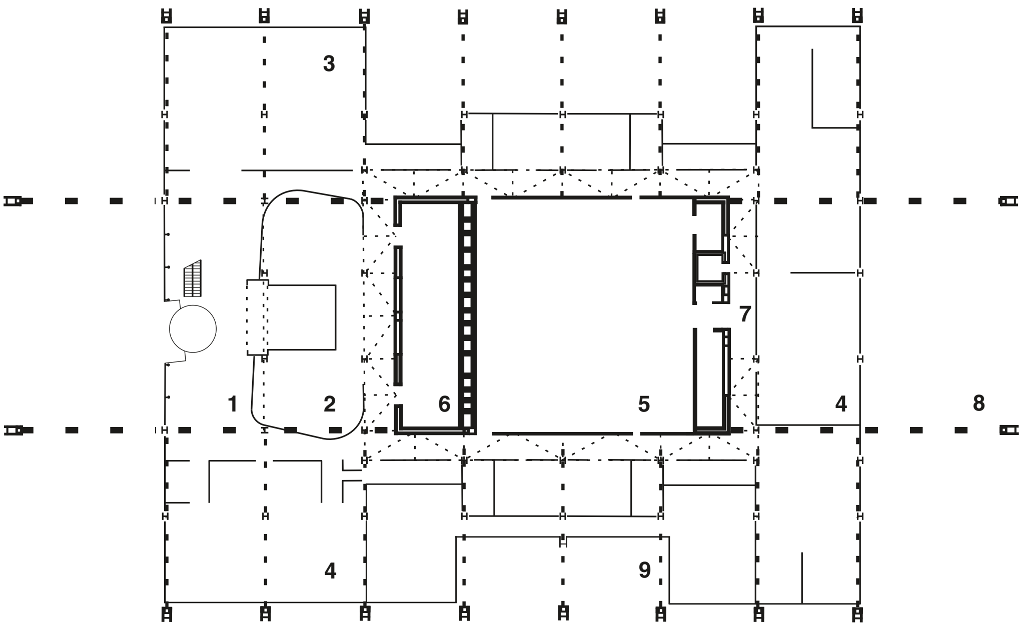
Located in Croydon, London, the BRIT School educates students in the performing arts and related skills. As the curriculum was still under development during the building design process, interior space had to be flexible enough to accommodate changing needs, including future expansion, yet incorporate an acoustically separated theatre and sound studios.

The architectural form embodies these programmatic requirements in a central three-storey core surrounded by a two-storey podium. Two contrasting structural systems, the load-bearing core and an exoskeletal framework, support the architectural form (Fig. 2.1). They are both equally responsive to the building programme. Heavy and relatively massive, the reinforced concrete masonry core satisfies acoustic requirements. From its corners, four primary roof trusses cantilever toward external piers located beyond the building envelope, and secondary trusses bear on its side walls to leave the first floor completely free of interior columns.

▲ **2.1** BRIT School, Croydon, London, England, Cassidy Taggart Partnership, 1991. Exoskeleton with the core behind the two-storey podium. Ventilation ducts protrude from the core wall.

▲ **2.2** Free-standing masonry piers in front of the building.

The two free-standing concrete masonry piers at the front and back of the building claim space likely to be incorporated into the building at a future date (Fig. 2.2). Spaced 20 m apart, too wide to signify entry explicitly, their placement approximates the width of the double-height entry atrium behind them. Eight smaller but similarly tapered piers, some placed well away from the existing building envelope where it steps back in plan towards the core, provide for anticipated outwards expansion (Fig. 2.3). They support steel frames, some of whose trussed



1 Foyer
2 Library
3 Restaurant
4 Classrooms
5 Theatre
6 Sound studios
7 Corridor with roof diaphragm
8 Primary propped-cantilever truss
9 Portal frame

0 5 10 m

▲ **2.3** Simplified ground floor plan.

▲ **2.4** Partial portal frames span between the piers and the primary trusses or core walls.

rafters connect directly to the core, and others to the primary cantilever trusses (Fig. 2.4). Slender longitudinal tubes interconnect the partial portal frames at their knee-joints, and together with a mesh of small-diameter tension rods, brace the framework members back to the core.

▲ **2.5** Exterior column recessed within an external wall.

Exposed structure plays numerous architectural roles on the exterior. Along the building, the piers and the steel columns they support are separated clearly from the building envelope. They modulate and enliven exterior walls with their visual mass and diverse materiality. The piers and portal frames define and limit the eventual extent of the expanded building footprint by defining the edges of potential infill spaces. The combination of masonry construction and pier tapering that expresses structural resistance to the outward thrusts from the portal columns suggests a buttressing action. This intensifies a sense of perimeter structure confining, protecting and supporting the two-storey podium. Steel trusses above roof level conceptually as well as structurally tie these external structural elements back to the core, which itself anchors the building visually and physically against lateral loads.

Exterior ground floor columns that support the first floor composite steel–concrete slab are recessed within light timber-clad walls (Fig. 2.5). These exposed columns and their bolted beam connections indicate the post-and-beam nature of the interior structure and provide advance notice of how well interior columns are generally integrated with partition walls. An absence of first floor columns on exterior wall lines emphasizes that the roof is supported by the exterior structure that spans the space between the perimeter and the core, providing column-free interior planning flexibility.

At the ground floor, interior columns placed on a repetitive rectangular grid allow for a satisfactory level of functionality. Almost all columns are positioned within interior walls. Spatial planning is well integrated with structural layout. Unfortunately, in two locations adjacent to walls surrounding the library, columns sit awkwardly in the circulation space. They disrupt both the expectation and the physical experience of walking around the gently curved flanking walls. Otherwise, structure, together with partition walls, defines interior spaces and circulation routes, the most prominent of which hug the core.

The architects have chosen to expose all interior columns, beams, the suspended floor soffit, and mechanical and electrical services. While this strategy typifies a tight budget it allows for ease of future adaptation. Design decisions have led to a celebratory exterior structure at the expense of more utilitarian structural detailing inside.

While structural detailing quality varies enormously from inside to out, innovative exterior steel detailing deserves special mention. Detailing of the tapered steel columns that rise from clearly articulated pin joints is most distinctive and original (Fig. 2.6). A steel hollow-section that is welded to a thin vertical and stiffened plate forms the column

▲ **2.6** Innovatively detailed portal frame columns, with the core and an 'anvil' support for the trusses in the background.

cross-section. Increasing the depth of the column with height expresses how the structural bending moment profile reaches its peak at the knee-joint. Outer areas of the thin steel plate furthest away from the hollow-section are suited to resisting gravity-load bending moment tension stresses. The radial and perpendicular orientated triangular stiffening plates enable the gravity-load tensile stresses to be carried around the corner of the knee-joint without the thin plate buckling radially, and increase the plate's compression capability under wind uplift conditions. As well as celebrating steel materiality and expressing structural actions, the column detailing exemplifies creativity and innovation. Contrast the quality of this detailing with a more typical solution comprising standard off-the-shelf universal column and beam sections!

After the columns 'bend' from a vertical to a horizontal orientation at their rigid knee-joints, their graceful transformation from steel plate and hollow-section form into trussed-rafters exemplify another innovative detail. The vocabulary of steel plates and hollow-sections expands with the addition of further unconventional details in the primary propped cantilevered trusses. At the point where they are propped by the external piers, steel truss members thicken and forfeit their sense of materiality. They could be either steel or precast concrete (Fig. 2.7). At the other end of the truss another detailing language appears – bolted side-plates with circular penetrations (Fig. 2.8). Such a diversity of structural languages can sometimes have a detrimental effect on achieving a visually unified structure, but in this building which celebrates creativity, the white painted steelwork provides sufficient visual continuity.

▲ 2.7 Detail of a primary truss to pier connection.

▲ 2.8 Primary truss near its connection to the core.

Adjacent to the masonry core walls, primary truss top-chord cross-sections change from steel hollow-sections to three tension rods. Articulating their state of tension clearly, they curve over a steel anvil-like support on the top of the core and continue horizontally through an intermediate support to meet an identical truss chord from the other end of the building (see Fig. 2.6). Although the horizontal rods are more highly visible when drawn on plan than seen on site due to their lightness of colour, their continuity along the length of the core walls expresses how the primary trusses counteract to support each other. They cantilever in a reasonably balanced fashion from each end of the core. Instead of burying the horizontal rods within the core walls, the architects articulate equal and opposite tension forces, and thereby intensify the visual richness of the exposed structure.

While generally less refined constructionally than their exterior counterparts, several interior structural members have benefited from special detailing treatment. Perhaps acknowledging the importance of first impressions, fine steel tapered-plate mullions and beams support the atrium wall glazing and the main entry canopy. This fineness of detailing also strengthens the visual link between exterior and interior structure (Fig. 2.9).

Natural light reaches deep inside the building through glazed roof areas over the corridors around the core perimeter. A similar pattern of narrower slots through the first floor slab enables light to penetrate to ground floor level. Daylight first passes through the exterior roof structure, and then through the diagonal in-plane roof and floor diaphragm bracing. But neither structural system modifies the light quality or quantity significantly. Structural openness and fineness, and its wide spacing minimizes any such influence (Fig. 2.10). Rather than the structure disrupting

▲ **2.9** Refined structural detailing in the atrium and to the main entrance canopy.

light, light highlights the structure. One is therefore more conscious than ever of these diagonal members in the floor plane and the roof. As they brace all outlying roof and floor areas back to the core to ensure the lateral stability of the podium, their diagonal geometry contrasts with the orthogonal ordering of the primary structure.

▲ **2.10** Roof and first floor diaphragm bracing.

Finally, this analysis of the BRIT School explores the representational and symbolic roles of structure. The contrast between a heavy and strong core and the podium's lightness and relative fragility might read as expressing the relative importance of theatrical performance in the school's life. The physical separation and visual differentiation of structure from the cladding might also be seen as an invitation and opportunity for future expansion. However, a more compelling example of meaning embodied in this structure resides in the detailing of the exterior structure, particularly the steel columns. Whereas 'visually emphasized or High-Tech structure' has been interpreted as expressing ideals of technical progress, in this case innovative structural detailing expresses the school's role of developing and fostering creativity.[1] This reading of the structure is not new. In the early years of the school, images of exterior columns featured on its letterhead.

Baumschulenweg Crematorium

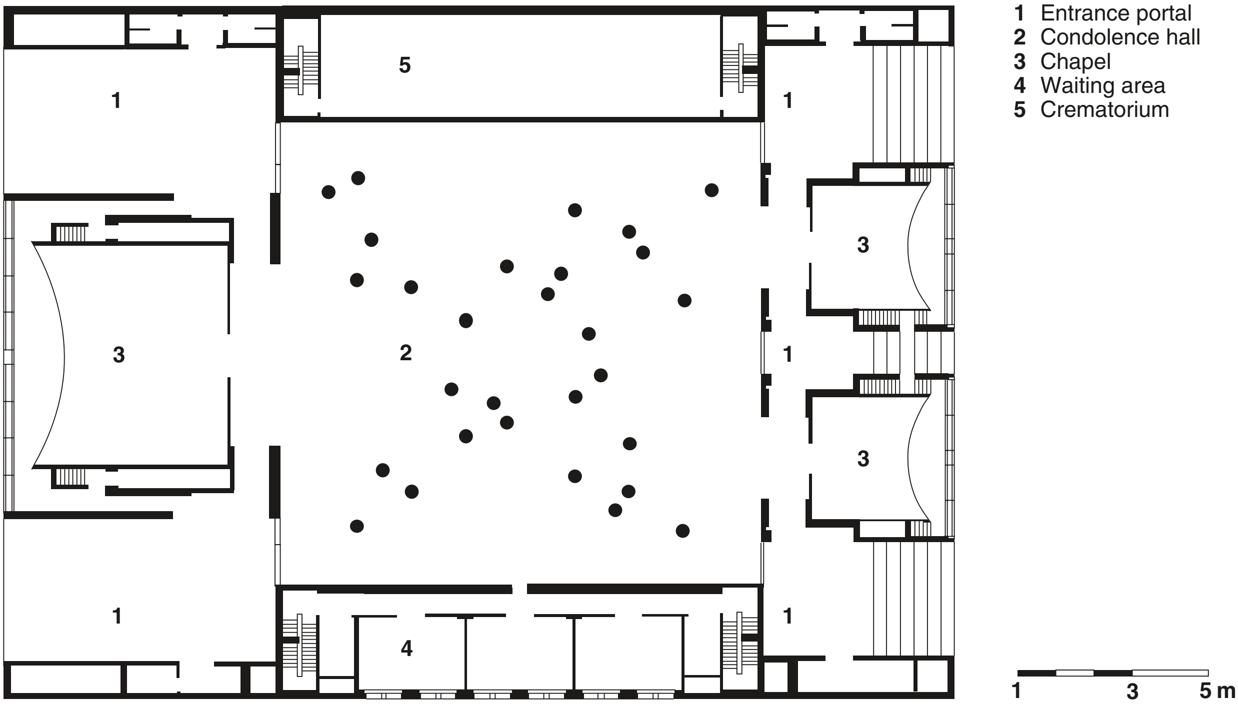
After proceeding through the gatehouse of the Berlin suburban cemetery and following a short walk along a tree-lined forecourt, visitors confront the symmetrical low-rise form of the crematorium. An

▲ **2.11** Crematorium, Baumschulenweg, Berlin, Germany, Axel Schultes Architects, 1999. Front elevation.

absence of exterior doors and conventional fenestration or other visual clues creates uncertainty in interpreting the building's scale (Fig. 2.11). Although the façade composition is read as single-storey, up to three storeys are accommodated above the main ground-floor level. Planar concrete elements in the form of perimeter walls, a raised ground floor and a roof slab define the rectilinear form.

Even from a distance, visitors become aware of the roof slab discontinuity. Above the two side-entry portals a roof slot reveals a glimpse of sky that one commentator refers to as 'a harbinger of the end of grief.'[2] These longitudinal slots continue through to the other end of the building. They slice the building into three independent structures even though common materiality and consistency of architectural language unite them visually. The outer two zones, to use Louis Khan's terminology, 'serve' the major central area that accommodates three chapels and a condolence hall (Fig. 2.12).

Walls dominate the exterior elevations, functioning as both structure and cladding. Side walls initially read as approximately 2 m thick, but in fact they are hollow – doors from the entry portals lead to rooms within the 'walls'. Elsewhere, relatively thin edges of exposed walls and slabs express the dominant structural language of wall that is repeated within the interior box-like modules that enclose one large and two smaller chapels. Ceiling slabs over these three spaces are also slotted, allowing light to enter through louvred glazing. Gentle curved ends to the ceiling slabs relieve an otherwise rigid adherence to orthogonality.



▲ **2.12** Simplified ground floor plan.

A study of the main floor plan indicates tripartite longitudinal subdivision – front and back porticoes and chapel spaces lie at each end of the centrally located condolence hall. Structural walls that are generously penetrated with openings at ground floor level separate and screen the chapels from the hall. Within each longitudinal zone, structural walls subdivide space transversely. In the middle zone, walls delineate the condolence hall from the side waiting rooms and the crematorium. In the front and back zones, walls play similar roles by separating circulation and services spaces from the chapels. Structural walls therefore dominate the plan, delineating the various functions. Only within the condolence hall have the architects introduced another structural language.

▲ **2.13** Condolence hall columns.

Columns comprise the primary architectural elements of this large interior volume (Fig. 2.13). Their presence, together with an unusual lighting strategy, results in a space with a special ambiance that is well suited to its function. The 'random' placement of columns recalls the spatial qualities of a native forest rather than an orderly plantation. Scattered large-diameter columns disrupt obvious linear circulation routes between destinations beyond the hall. One must meander. Tending to cluster in plan along diagonal bands, columns subdivide the main floor area into four relatively large spaces, and many others that are smaller and ideal for groups of two to three people. Differently sized and shaped open areas become gathering places.

One of the largest 'places' is located in front of the main chapel. Dwarfed by massive, 11 m high columns, mourners meet to console one another. Columns either facilitate this interaction by virtue of their enclosing presence or provide opportunities for anonymity. They remind visitors of their human frailty, yet might even be a source of reassurance given their physical and symbolic qualities of strength and protection. Their scale instils a sense of awe rather than of intimidation.

The scale of the condolence hall and its columns, as well as its low light levels, recalls hyperstyle construction, both in its original Egyptian setting and in more accessible locations, such as in the basement of L'Institute du Monde Arabe, Paris. But, whereas hypostyle column layout conforms to a rigidly ordered square grid, the crematorium column placement can be described as unpredictable.

Here, the grid has disappeared. According to Balmond, with columns free of the grid, space is no longer 'dull and uninspired'. He describes how, during the design process, two rows of columns were 'freed-up' in a gallery hall at the Rotterdam Kunsthal by 'sliding' one row past the other in an 'out-of-phase shift': 'Suddenly the room was liberated. Diagonals opened up the floor plan and the room became one space, not two ring-fenced zones . . .'[3] By comparison with columns at the Kunsthal, those at the crematorium enjoy far more freedom even though they remain straight and are vertical.

▲ **2.14** Annuli of light as column 'capitals'.

A masterly introduction of natural light intensifies this powerful and surprising experience of interior structure. At each roof slab-to-column junction, an area of critical structural connectivity, an annulus interrupted only by a narrow concrete beam allows natural light to wash down the column surfaces (Fig. 2.14). Daylight illumines longitudinal side walls similarly. Slots adjacent to walls disconnect the roof slab from its expected source of support. Just where shear forces are normally greatest, the slab stops short, cantilevering from the nearest columns. Light enters through the slots and illuminates and reflects off the structure (Fig. 2.15). The conventional grey cast-in-place concrete of walls, columns and roof slab combines with intentionally low light levels to heighten a sense of solemnity and calmness.

Unlike the BRIT School with its diversity of structural materials, its structural hierarchy and celebratory detailing, the crematorium's structural drama and interest results primarily from structural simplicity, generosity of scale and its configuration. Structural detailing can be

▲ **2.15** Light-slot between the side wall and the roof slab.

described as plain. Columns are of identical diameter with an off-the-form surface finish. As plain cylinders, lacking a pedestal or a capital other than the annulus of light, they emerge starkly from the stone floor surfacing at their bases to fuse monolithically with the beam stubs and the flat planar roof slab soffit above. Surface textures relieve wall surfaces. Formwork tie holes and regularly spaced positive joints, as opposed to more conventional negative formwork joints, modulate large wall areas. Regular vertical niches spaced along the condolence hall longitudinal walls play a similar role (Fig. 2.16).

▲ **2.16** Texture and niches of the condolence hall side-walls.

Minimalist structural detailing denies any expression of structural actions. Uniform column size belies the different loads supported by each. Columns that are well separated in plan from other columns bear heavy compressive loads while due to slab structural continuity, some closely spaced columns experience minimal compression. Although these lightly laden columns could have been removed during the design process by simply modifying the slab reinforcing layout, an apparent increase in structural efficiency by decreasing column numbers would have diminished architectural aspirations. Similarly, a reluctance to taper the slab depth in those areas where it cantilevers, indicates the preciousness of a simple and solemn orthogonal architectural language.

The interior structure of the condolence hall exemplifies the potential for structure to enrich interior architecture both aesthetically and functionally. 'Random' column layout, structural scale commensurate with volume, and interaction of structure and light enliven a large volume, stimulating a variety of reactions and emotions, and actively facilitating its intended use.

SUMMARY

These studies of the BRIT School and the Baumschulenweg Crematorium begin to illustrate the potential of structure to enrich architecture. While the exterior structure of the school makes significant aesthetic contributions, interior structure is notable only at the crematorium. Although both structures convey meaning, the contrast in how one reads and experiences them is striking. As the relationship between architectural form and structural form is investigated in the next chapter, the diversity of experience that structure offers continues to surprise.

REFERENCES AND NOTES

1 Macdonald, A. J. (1997). *Structural Design for Architecture*. Architectural Press, p. 32.
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3 Balmond, C. (2002). *informal*. Prestel, p. 79.