Office building employing structural storage concept, Johannesburg (RSA)

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3. Office Building Employing Structural Storage Concept, Johannesburg (RSA)

Owner:	*The Standard Bank of South Africa Limited*
Architect:	*MLH and Partners*
Mechanical and Electrical Engineers:	*Ove Arup Incorporated Spoormaker and Partners*
Contractor:	*Trescon (Pty) Limited*
Service data:	*Nov 1982*

Particulars of Building

A six storey reinforced concrete building to house the administrative functions of the Bank. It has a gross area of nearly 60000 m² comprising four typical, open, landscaped office floors each measuring 165 × 58 (average) metres giving an area of 9700 m² per floor. Designed in 1979, construction started in March 1980 and the building was occupied in November 1982.

Objectives

- Elimination of large internal daily temperature swings common to light, thermally inefficient buildings, by designing a heavy, thermally efficient structure with a more constant internal temperature, thereby reducing the quantity of energy required to bring about comfort conditions (Fig. 1).
- Reduce reliance upon mechanical systems by optimising the use of natural climatic conditions such as the cool night air, a characteristic of the high, dry Southern African plateau.
- Apply the structural storage concept by utilising the concrete structure as a heat sink.
- All workstations in open landscaped office to have individual air conditining and lighting controls.
- Provide office space with unimpeded flexibility for quick, easy, economical repositioning of workstations to satisfy a dynamic organisation.
- Lighting not to exceed 20 W/m² and total energy consumption helf to around 130 kWh/m².
- Integrate sprinkler protection system, airconditioning, voice and data transmission and power requirements with the energy saving features.
- Total construction cost not to exceded that of a conventionally designed, air conditioned and illuminated building.

Methodology

The building was designed as a compact, rectangular, low rise structure (Fig. 2). Double glazed windows comprise no more than 20% of facade area. Roof and perimeter walls are insulated and fire excape stairs, placed externally, are naturally lit and ventilated. The reinforced concrete slab of approximately 500 kg/m² was sized to absorb the predicted daily heat load which is drawn off every night by passing cool night air through the building. The use of the exposed "waffle" or"coffered" slab is not only an economical structural solution with 11400 column centres, but it also provides the maximum surface area through which to absorb and release heat in a 24 hour cycle. A standard steel, 450 high, raised flexible floor system throughout integrates all services in an easily accessible underfloor void which also functions as an air plenum. This eliminates the use of conventional ducting and ensures that the surface of the concrete is in contact with the air. A central roof plant supplies primary air to the floor plenum via hollow concrete columns and aus full use is made of the heat storage capacity of the structure which is exposed on all

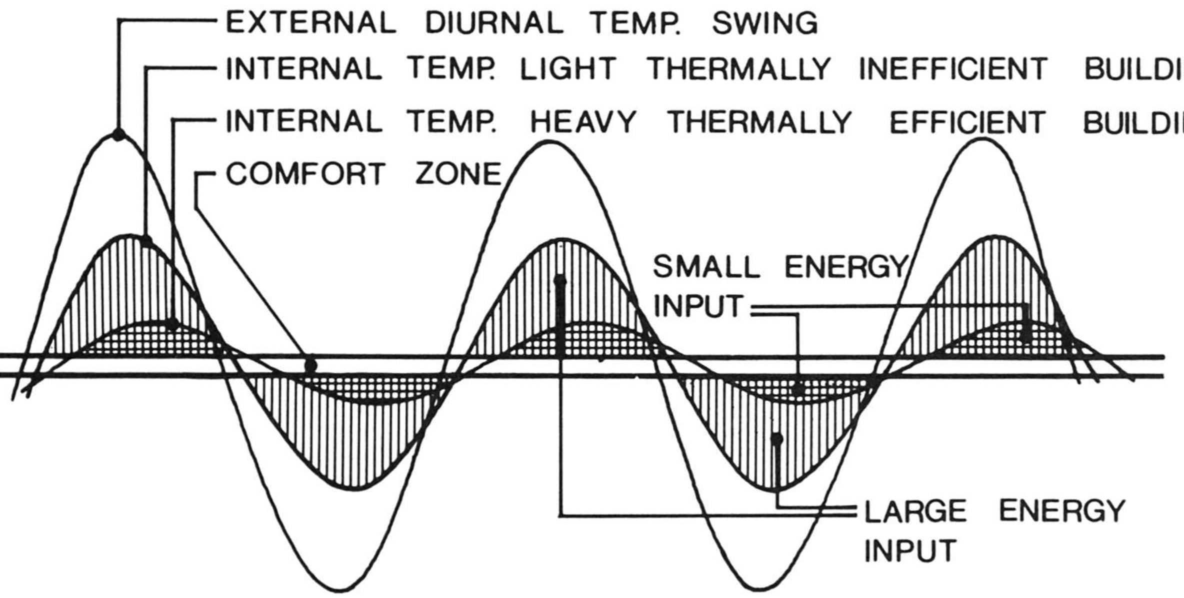

Fig. 1. Comparison shows thermally efficient building requires less energy to create comfort conditions than a thermally inefficient building

Fig. 2. The Standard Bank Administration Building

sides and in direct contact with the air, the plant is sized for average daily heat load only with the flywheel effect of the structural mass providing built-in standby capacity. Chiller capacity and plant size was a third less than that which would have been required for a conventional building of similar volume.

Specially designed, indivually controlled fan-assisted, floor outlets draw air from the plenum, providing an air flow pattern that coincides with the natural heat flow, upwards into the coffered concrete slab. Return air is drawn out though openings below the concrete ceiling, into insulated vertical precast concrete ducts between the windows, forming an "air skin" around the buildidng, as shown schematically in Fig. 3. The vertical nature of the facades is thus a true expression of this function! Fig. 4 shows the vertical air ducts being placed against the structure.

At workstations a specially designed outlet in the floor panel acts as desk and light anchor through which all power, voice and data cables as drawn after connecting to their respective sockets and circuits in the underfloor ducting, as shown in Fig. 5. Fan air terminal draws air up for occupant of workstation.

With all services laid on the concrete floor, overhead services and work is eliminated, greatly increasing speed of installation. No suspended ceiling is therefore required to hide services. Individually controlled ambient/task lighting fixtures with 250 watt metal halide lamps provide 450 – 500 lux on workstation desk tops.

To record temperatures, 10 sensors were placed in various positions. These were on the surface of the slab and inside at various depths, in the floor plenum and at different heights in the landscaped area.

A closed solar hot water system with heat exchanger and 100 collector panels was placed on the roof to provide a minimum of 11 000 litres of hot water per day, with a predicted payback of 5 years and an accumulated saving after 10 years of R 270 000.

Results

Recording and data collection has now ceased. The top third of the 150 mm thick concrete slab showed a fairly stable 19.5 degrees C and the lower third 21.5 degrees C. Initially eight recording points per floor showed average temperatures of 24.4 degrees, 23.9 degrees, 24.1 degrees and 24.7 degrees C, on 1st, 2nd, 3rd and 4th floors respectively, with a variation of 1.5 degrees C per floor. Final results showed all floors ranging between 22 degrees and 23 degrees, including perimeter zones. Total power consumption initially was around 130 kWhrs/m^2 for the total building but now after 3 years occupancy, it has increased to approximately 190 kWhr/m^2, due to the large numer of temrinals and the amount of electronic equipment installed during this period. Power requirements for lighting have worked out at 16 W/m^2.

Working conditions equal to the best have been provided at no additional cost, when compared with conventional buildings with similar finishes. The value of the electrical and mechanical sub-contracts was less than 20 % of the total building contract, whereas sit ranges form 26 % – 32 % for conventionally airconditioned and

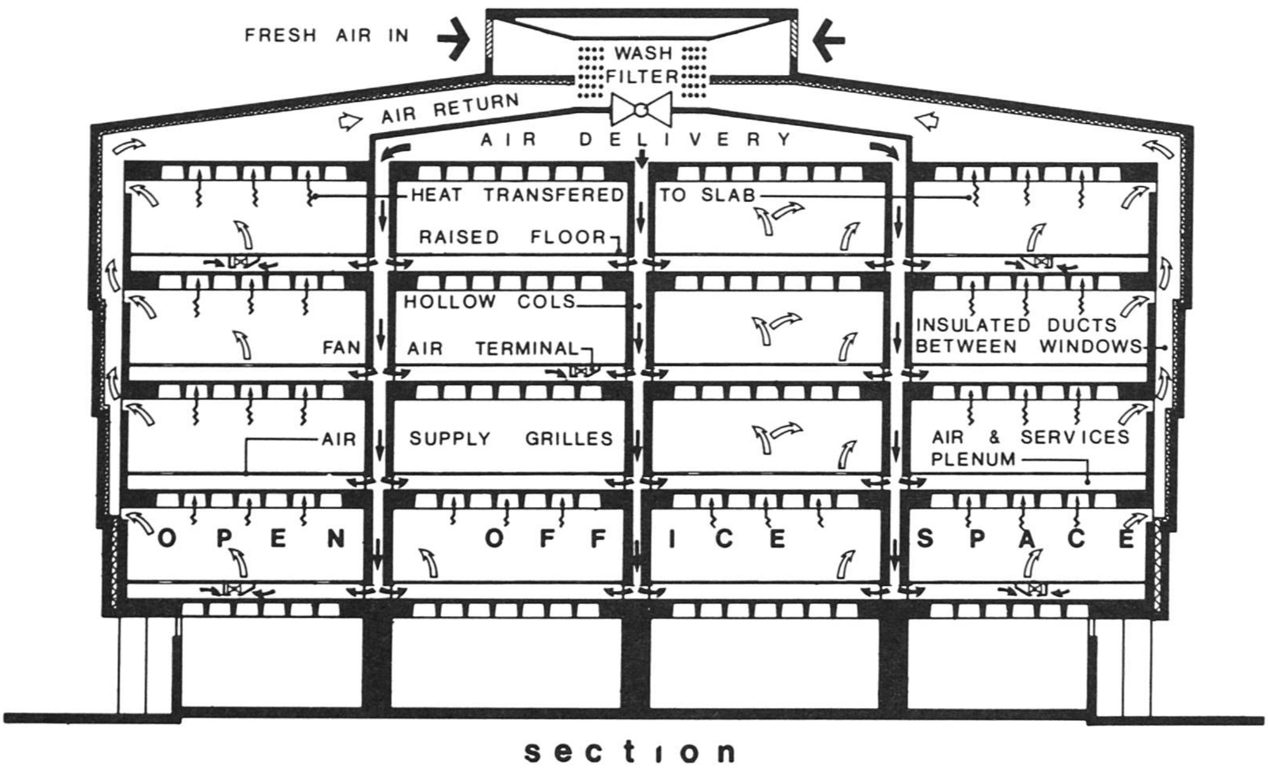

Fig. 3. Schematic showing air circulation in raised floor and structural storage system

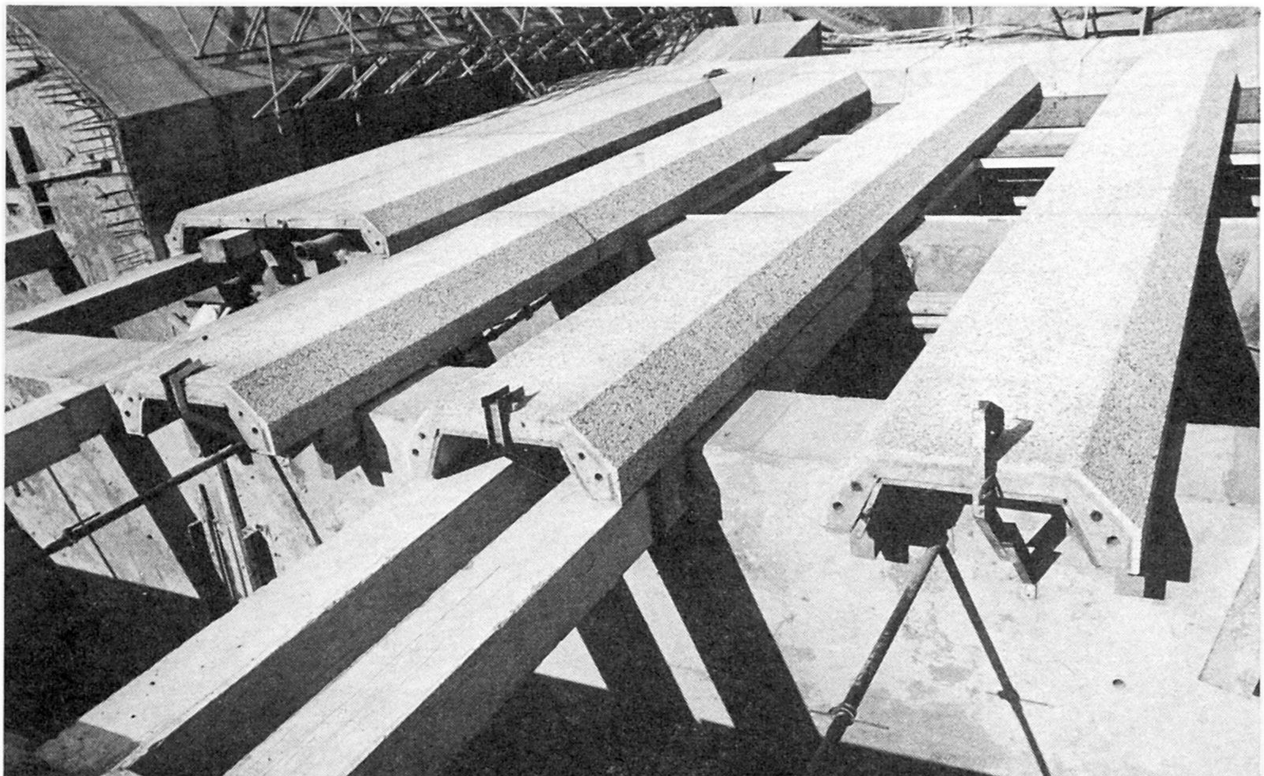

Fig. 4. Insulated precast concrete return air ducts between windows being fixed to edge of structure

illuminated office buildings which do not provide similar flexibility nor the ability to adapt to the systems and requirements of the occupant and his electronic equipment.

At a completed cost of R 525 per m^2, the building was below the local average cost for office buildings constructed atg that time, with similar finishes. Furthermore, annual electrical consumption costs are 50% less per m^2 than for the Standard Bank's prestigious office building, a 30 storey tower in which comparatively little electronic equipment has been installed.

The floor plenum permitted the subsequent laying of kilometres of data and other cabling which could not have been accomodated in standard in-slab ducting or within a suspended ceiling.

Postscript

The building was the 1984 winner in the architectural section of the national "Energy Effective Design in Buildings" competition.

The building has proved so satisfactory that the Standard Bank is now building another administration building of similar design and area across the street.

In Johannesburg, the same structural storage concept has now been applied to a small office building where the inert masonry structure itself acts as the climate moderator and only fans and filters comprise the total airconditioning system. Recorded internal temperatures hold stead between 21.5 and 23.5 degrees centigrade, in spite of large external swings.

(W.A. Birrer)

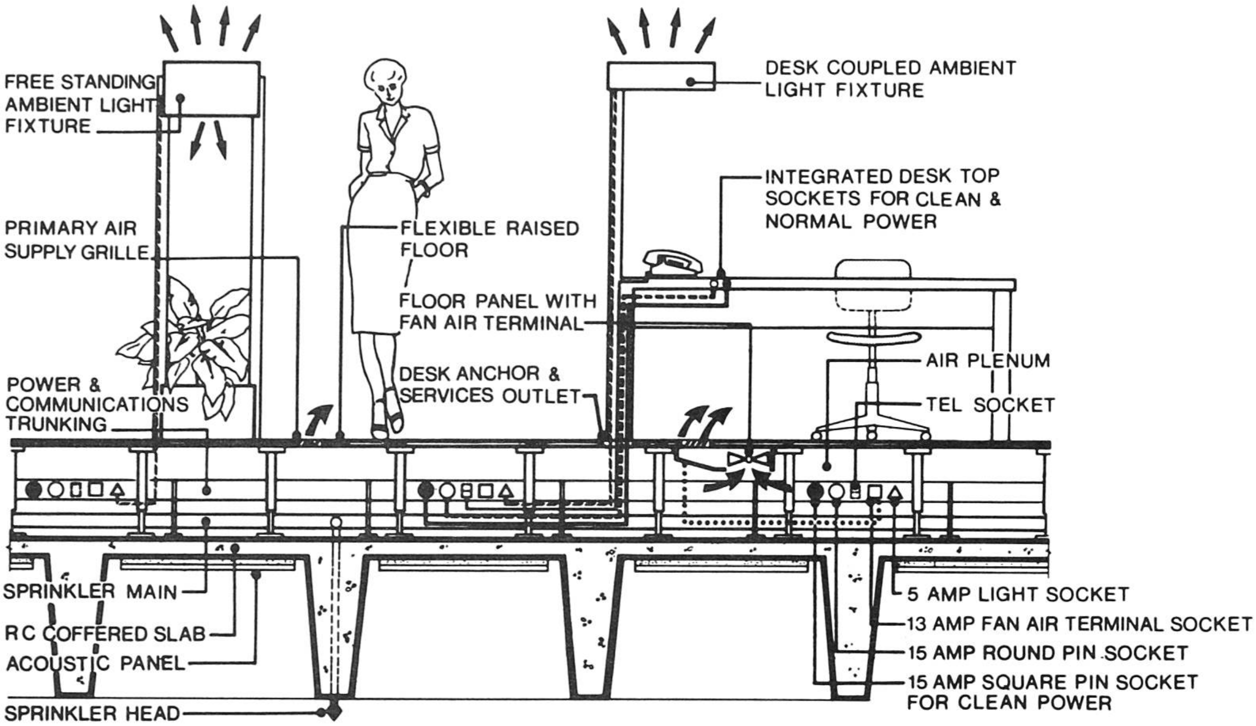

Fig. 5. Typical interface of system with workstation