Design for Energy Efficiency

Transport Corporation of India Ltd, Gurgaon

Architects **Ashok B Lall Architects** Delhi

Although this is an air-conditioned building, it attempts an interactive interface with the external environment to achieve greater energy efficiency. More importantly, it imbibes an experience of seasons as an aspect of a work environment.

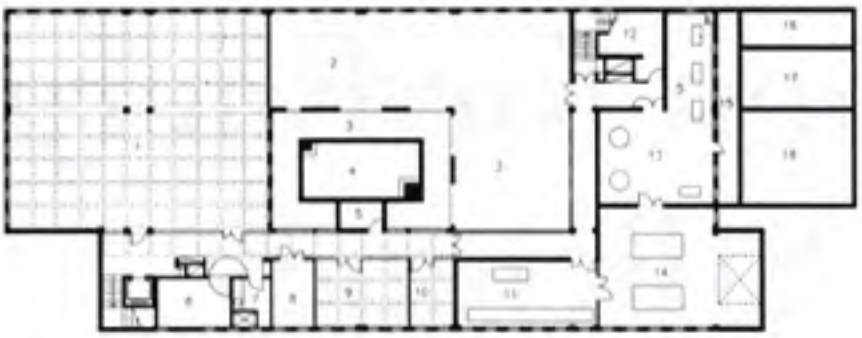
The basic design strategy is inspired by the traditional inward-looking *haveli* plan. The central fountain courtyard acts as an environment generator for the office spaces opening towards it. The external skin is treated as a solid insulated wall with peep windows for possible cross-ventilation and higher windows for daylight. Selection of materials and system of environmental control is prioritized in favour of sustainability and efficiency in energy consumption.

This is an office building designed to meet the demands of a modern office, with high level of environmental comfort, integration of systems to support information technology, with flexibility and adaptability for growth and change.

The building sits on a rectangular plot in an 'institutional' area, which will have other office buildings surrounding it. Three storeys of offices and a basement surround the central court. The basement houses building services and some work spaces too.

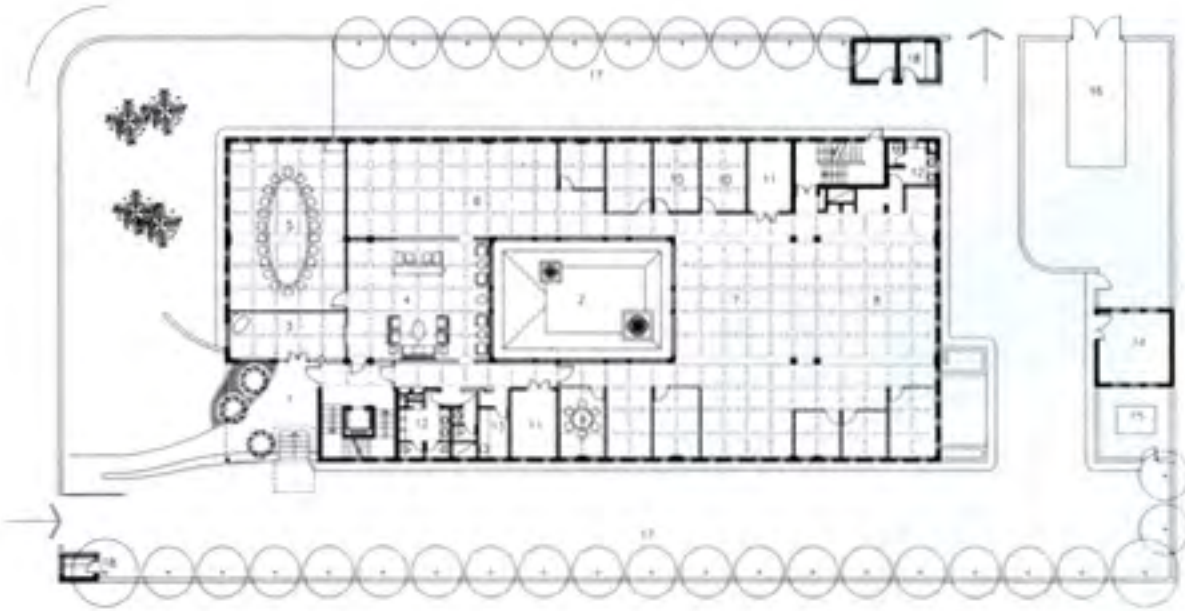
The entire building plan is based on a planning grid of 1.4 m x 1.4 m which coordinates the ceilings with air-

Left *Front view with garden terrace at the corner shaded for summer.*



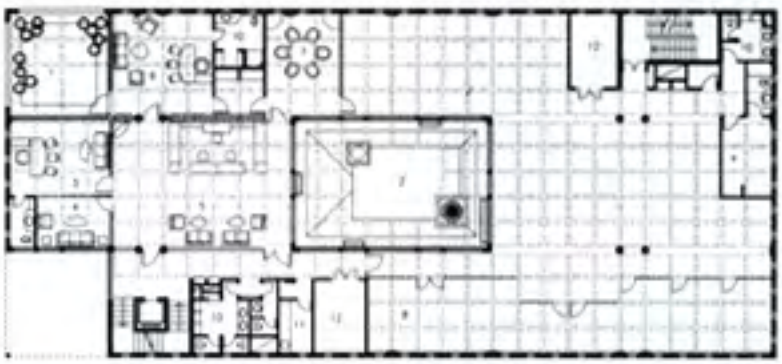
1 OFFICE
2 RECORDS
3 STORE
4 WATER TANK
5 PUMPS
6 STORAGE ROOM
7 PANTRY
8 AHU
9 GYMNASIUM
10 SECURITY
11 ELECTRICAL PANELS
12 UPS
13 SOFTENING PLANT
14 GENERATORS
15 PIPE GALLERY
16 SOFT WATER TANK
17 DOMESTIC WATER TANK
18 FIRE TANK

BASEMENT PLAN



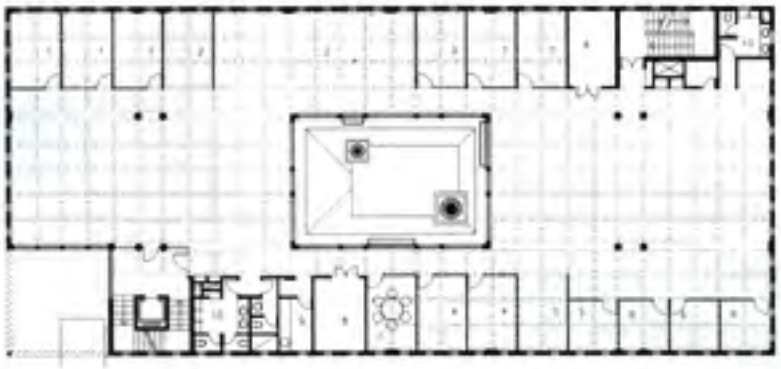
1 ENTRANCE COURT
2 FOUNTAIN COURT
3 LOBBY
4 RECEPTION
5 CONFERENCE
6 INFORMATION TECHNOLOGY
7 H.R.D.
8 X.P.S.
9 MEETING
10 SERVER
11 AHU
12 TOILET
13 PANTRY
14 HT PANEL
15 TRANSFORMER
16 FUEL STORAGE YARD
17 PARKING
18 GUARD'S ROOM

GROUND FLOOR PLAN



1 TERRACE
2 COURT
3 DIRECTOR
4 LOUNGE
5 SECRETARIAT
6 MD
7 MEETING
8 LIBRARY
9 GUEST ROOM
10 TOILET
11 PANTRY
12 AHU

FIRST FLOOR PLAN



1 AUDIT
2 ACCOUNTS
3 FINANCE
4 MANAGEMENT
5 LOGISTICS
6 OPERATIONS
7 MEETING
8 AHU
9 PANTRY
10 TOILET

SECOND FLOOR PLAN

SECTION

View of fountain court through the etched glass partition of a meeting room.

conditioning and light fittings, locations for partitions as well as external windows—to permit a high degree of flexibility in layout for offices.

The building opens towards its entrance through a planted and shaded forecourt with a water pool. The orientation of all the interior spaces is towards the central court, with the exception of the managing director's suite which enjoys its own garden terrace on the top floor.

Energy Saving Features

Exposure: The building adopts a compact rectangular form and a minimum height above the ground to limit exposure to the external conditions. Openings on the external walls are designed for two separate functions: small peep windows at seating height provide for possible cross-ventilation and views outside; larger windows at ceiling level are designed to distribute glare-free daylight across the office floor. Taking the daylighting function into account, the window area is minimized to 18% of the external wall area.

Both the entrance forecourt and the central fountain court, towards which the building envelope opens out with greater transparency, have a structural framework which would provide support for shading screens to be stretched according to seasonal demands. The planting scheme along the edges of the site with tall evergreen (Silver Oak) trees, provides another protective layer for the building.

Insolation: The orientation of the building is determined by the site. The small peep-windows, due to the deep reveal in which they are set, allow insolation in winter, cutting out the mid-summer sun by the shade of the reveal onto the glass. The large daylight windows house adjustable venetian blinds in a double-window sandwich.

Entrance court

External cladding of rough-split red sandstone dry-hung with pre-cast terrazzo jambs and cills around windows.

The blinds are to be adjusted seasonally (three times a year) by the building maintenance staff to control direct insolation and to reflect light towards the ceiling for distribution into the office spaces. The large glazed areas towards the central court and the entrance court rely on screens that will be stretched and gathered seasonally. The structural frameworks enclosing the courts provide the necessary support systems for the screens. It is planned that the screens would be works of art in themselves which play upon opacity, transluscency, reflection and colour as ways of accentuating the experience of seasonal change.

Heat Transfer: In principle, is a heavy mass construction insulated from the outside. Wall insulation is 25 mm thick polyurethane foam protected by a dry red-stone slab cladding system. The roof insulation is 35 mm thick and has a reflective glazed tile paving cover to minimize sol-air temperature on the roof surface. The daylight windows provide insulation by way of tight-sealed two layers of glass with a venetian blind installed between the two layers.

The glazing panels around the inner courtyard, however, are single glazed—it is anticipated that with the tall water fountain working, the courtyard temperatures would shift substantially towards wet bulb temperature. This would considerably reduce heat load from the courtyard side during summers, and would act as a heat sink during spring and autumn.

Fountain Court: The fountain court is an environmental device that seeks to combine the principles of physics, perception and cultural psychology to produce an aesthetic language in which 'nature' is reinstated as a beneficent force in architecture. The fountain is

designed as a visible object in which water can be seen and heard from all levels of the building, catching the light from above and in various forms of movement. The use of white textured concrete of the columns and white marble of the pool establishes its status, by association with tradition, as a work of art.

The fountain is a re-circulating system in which a large body of water flows over extensive surfaces to maximize evaporation. The tall solid concrete columns of broad diameters over which the water trickles down the height of the courtyard, and the thin sheet that overflows the sides of the pool at ground level, create a large heat sink and a body of air close to set-bulb temperature. The white marble sides of the tank reflect the courtyard light into the basement work areas.

Absorption technology for Air-Conditioning

After a careful cost-benefit study, an absorption system chilling plant has been installed. Apart from not contributing to ozone depletion, the plant results in reduction of capital expense of the electrical system, particularly its electricity generation back-up. This must cater to 100% peak load. The absorption chillers run on a diesel fired furnace. Electricity generation provides for illumination, working of back-up office machines and mechanical equipment.

Air-Distribution

Each of the office floors is served with two air handling units. The allocation of areas handled by each unit is designed to balance out peak demands from each unit. This is done by responding to the orientation exposure of the building sides to the sun so that peak morning and afternoon loads are shared by the air handling units, even as the loads shift from the easterly faces of the building in the morning toward the westerly faces in the afternoon.

Control on air-conditioning loads

The primary level controls on external gains has been described under 'exposure' and 'heat transfer'. Internal gain is controlled by minimizing internal lighting loads (see 'illumination').

The more significant saving, however, is affected by the clients agreeing to air-conditioning standards set according to acceptance level of their office staff, rather than by any international norms. The system is designed to following parameters:

Outdoor Summer: 43.5°C db
24°C wb (ignoring peak temperatures)
Indoor Summer: 24°C db (1°C)

Also, circulation passages and ancilliary function rooms have no air-conditioning. Toilets and pantries expel air to the outside at a minimal rate drawing relief air from neighbouring conditioned spaces.

Illumination: Daylight is the primary source of illumination. All work spaces receive adequate daylight, the maximum distance of a work-station from the daylight source being 5m. The high windows on the external walls are

Courtyard seen from the reception at ground floor.

designed to throw daylight deep into the office space. This is varied seasonally by adjusting venetian blinds installed in the window sandwich to control glare and modulate distribution. On the courtyard side, fabric screens would be stretched over the structural frame to respond to each season.

Artificial illumination is on the ceiling grid with compact fluorescent luminaries at 19 watts per square metre of floor area. Most of the office work is done on computers and working hours are generally limited to daytime. The illumination level offered by this system supplements daylight when necessary, and is comfortable for short working hours. It has been agreed that task light desk lamps will be provided on desks for elderly people and those with late working hours. To provoke visual interest and a feeling of brightness, occasional spot lights are provided to light up wall surfaces with paintings and other artwork.

Control of ceiling lights is in the hands of the building management staff. The control circuits for ceiling lights are arranged in zones running parallel to the daylight source so that they can be switched on progressively to compensate for variation in and/or falling daylight levels. It is proposed that these will be controlled by automatic timer switches with timing set for each season (with manual override for unusually cloudy weather).

A significant feature of energy saving is the economy of the building envelope.

Structural System and Floor-to-Floor Height

A flat-slab system is adopted for floors and roofs. This minimizes the height

View of entrance court from main stairs.

required for accommodating air-conditioning and other services. With a clear ceiling height for office spaces at 2.65 m, the floor-to-floor height for the building is 3.50 m. This compactness of height means minimizing heat transfer through vertical surfaces of the external skin.

Restricting the building height to three storeys was a deliberate choice. With maximum ground coverage, this pattern of planning consumes the total permissible FAR with the least possible building height. The advantages are manifold: the energy consumed in transport of materials to heights during construction is minimized. Similarly, the energy consumed in conveying water and diesel for the A/C plant on the roof is minimized. A major gain is being able to eliminate the necessity of lifts. Only one six passenger elevator is provided for disabled or ill people and special guests.

Embodied Energy

It is in the deployment of finishing materials of the building that some gains are affected by conscious choice. The criteria for choice of materials was that within the constraints of performance specifications demanded of the surface, the material should be chosen from the nearest possible source and call for minimum processing towards converting or installing it. The external cladding is undressed split red Agra sandstone with pre-cast concrete and terrazzo cills and jambs. For office areas, floors are made up of pre-polished granite from Jhansi (the nearest source to Delhi) and for service areas it is the Kota Stone. Glass and aluminium are the worst culprits whose areas, sizes and weights are kept to the minimum as far as possible.

Monitoring and Automation

The present automation in the air-conditioning system is limited to the solenoid control valves and thermostats for regulating the flow of chilled water to the air handling units and the switching on and off of the absorption chiller units; and for artificial illumination the use of switches on timers. More sophisticated computerized automation systems were found to be beyond budgetary provisions and of doubtful cost-benefit. However, it is proposed to install a simple monitoring system for illumination and air-conditioning to help in rationalizing the system management routines for the daily as well as the annual cycles of building use. ✧

Client *Transport Corporation of India Ltd.*
Year of completion *1999*
Total Built-up area *2750 sqm*
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Consultants	Structural Engineering Electrical & Fire Detection Plumbing & Fire Protection HVAC Landscape Design	*Planning & Design Bureau* *Engineering Services Consultants* *Mr. Tej Pal Singh* *Udayan Chaudhari & Associates Pvt. Ltd.* *Mini Gardens*
Courtyard Sculpture		*Mr. S. Nandagopal*
Contractors	Civil, Plumbing & Fire Protection Electrical & Fire Detection HVAC	*M/s Gurbakhsh Singh B.A. Builders Pvt. Ltd.* *M/s Hitect Erectors Pvt. Ltd.* *M/s ETA Engineering Pvt. Ltd.*