

**COST - EFFECTIVE DESIGN FOR  
AIR-CONDITIONED OFFICE SPACE :  
TRANSPORT CORPORATION OF INDIA LTD.**



**ASHOK B. LALL ARCHITECTS, NEW DELHI**

**TCI HOUSE** is a modern office building with a high level of environmental control, integrating systems to support information technology, and a requirement for flexibility and adaptability for change in its internal layout arrangement.

The basic design strategy is the traditional inward-looking '*haveli*' plan with an internal fountain court that acts as an environment generator for the office spaces opening towards it.



The external envelope is treated as a substantial protective envelope with small windows. The envelope opens at the entrance portico and at the roof terrace garden as a gesture towards the street.

**We have attempted in this building to minimise energy consumption and particularly for air conditioning through various strategies in the design of the building fabric :**

**EXPOSURE**

**INSULATION**

**HEAT TRANSFER**

**INFILTRATION**

**INTERNAL MICROCLIMATE**

**ILLUMINATION**

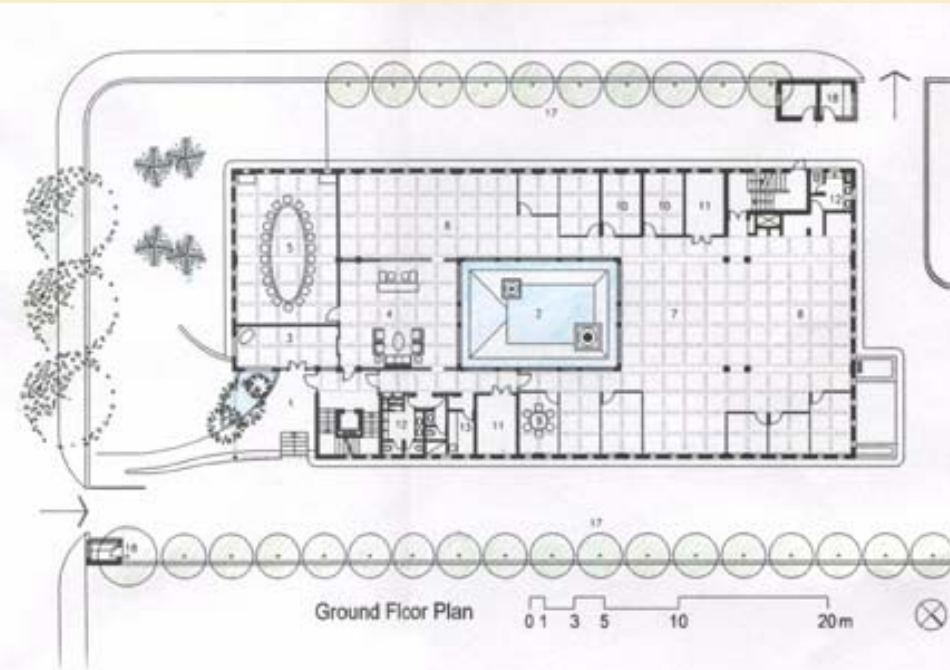
# EXPOSURE

- **COMPACT SHAPE & COMPACT HEIGHT**

Controlling exposed surface area to floor area ratio.

- **ORIENTATION !?**

Dictated by site and building setback lines.



# INSOLATION

## □ SUPPORT FRAMEWORK FOR SHADING SCREENS

- *Retract/ remove in winter, stretch in summer*
- *forecourt*
- *fountain court*
- *garden terrace*

## □ TREES AND PLANTS

- *Shade external walls, early morning and late afternoon*



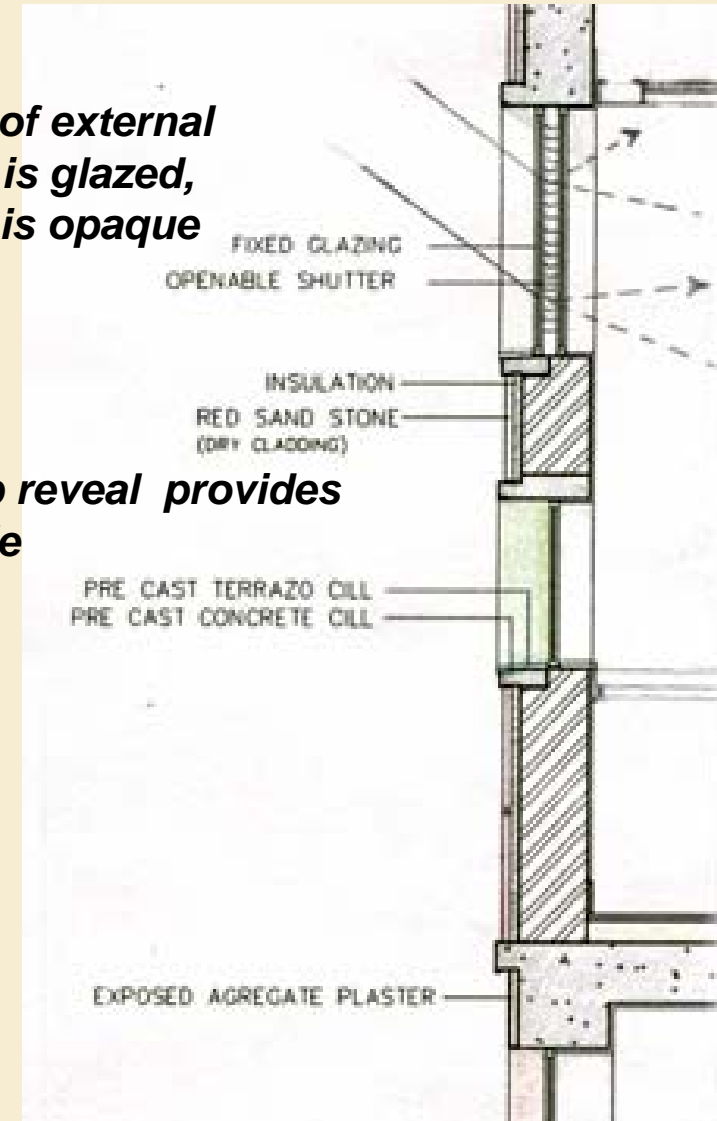
# INSULATION

- CONTROL WINDOW AREA
- VENETIAN BLINDS IN SANDWICH WINDOWS & EXTERNAL GLASS IS TINTED
- SELF SHADING FOR SMALL WINDOWS



- 18% of external wall is glazed, rest is opaque

- Deep reveal provides shade



# HEAT TRANSFER

External wall area badly exposed to low morning/ afternoon sun. therefore, control heat transfer through walls.

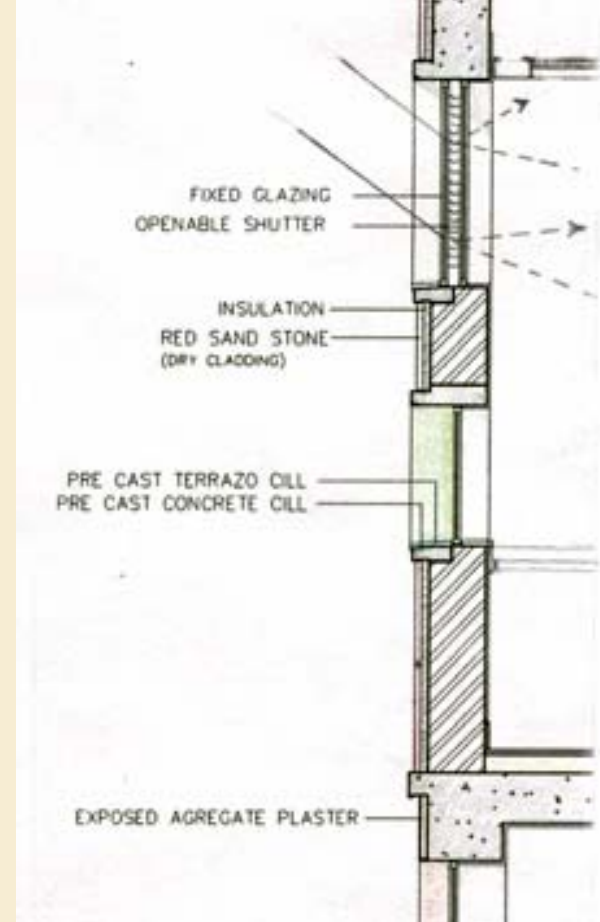
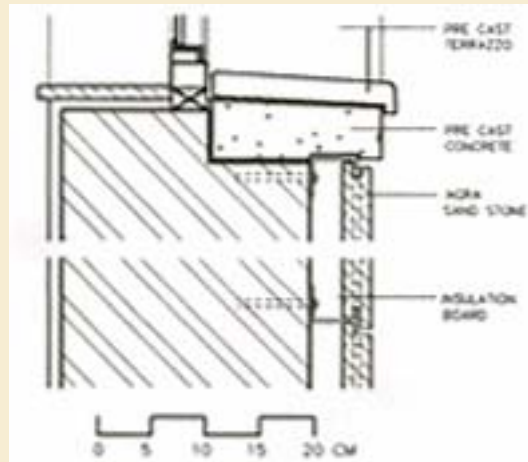
## □ U - VALUE OF EXTERNAL WALL

Large window (11% of wall area) - 2.8 watts/sqm k  
Small window (5% of wall area) - 6.42 watts/sqm K  
Opaque area (81% of wall area) - 0.75 watts/sqm K  
Effective (average) "U" value - 1.35 watts/sqm K

## □ HEAT TRANSFER THROUGH ROOF

Reflective Roof Surface

U - VALUE OF ROOF - 0.6 watts/sqm K



# HEAT TRANSFER

- COURTYARD GLAZING !?



- THERMAL MASS

# INFILTRATION

- Tight windows
- Air lock lobby at entrance

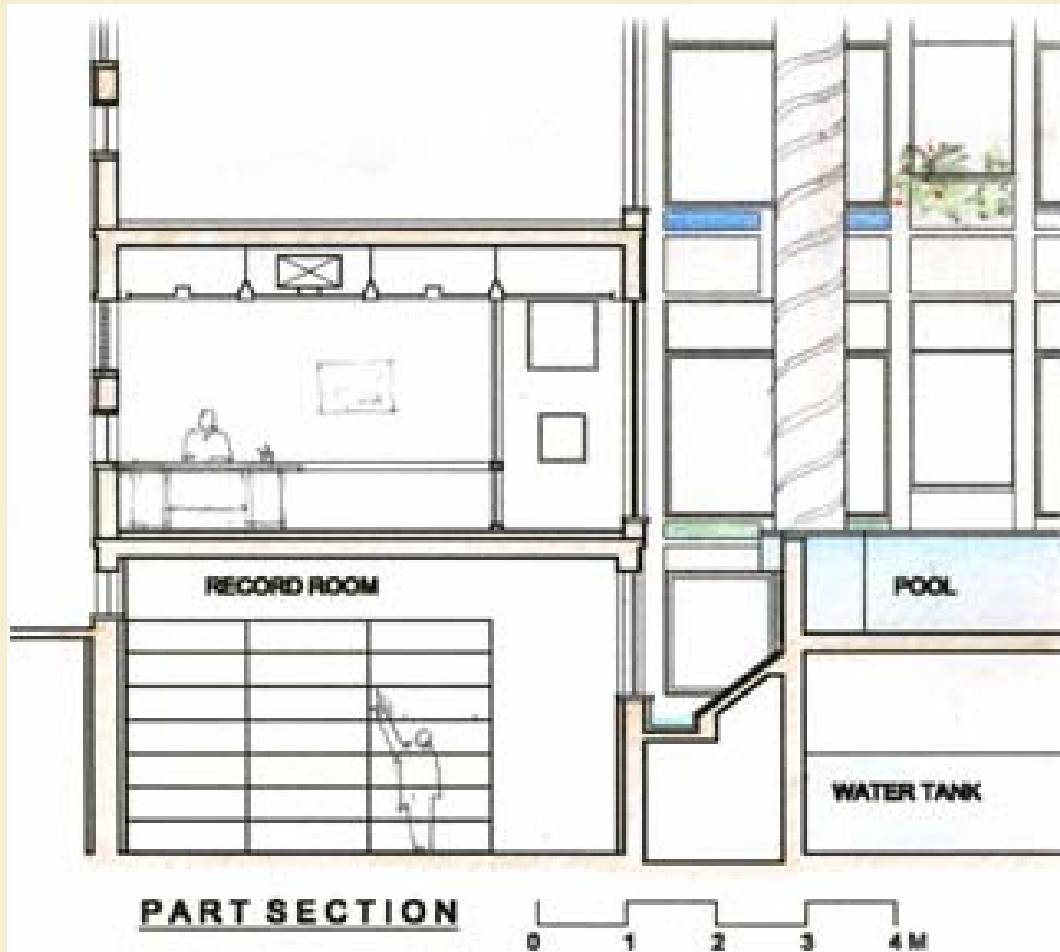




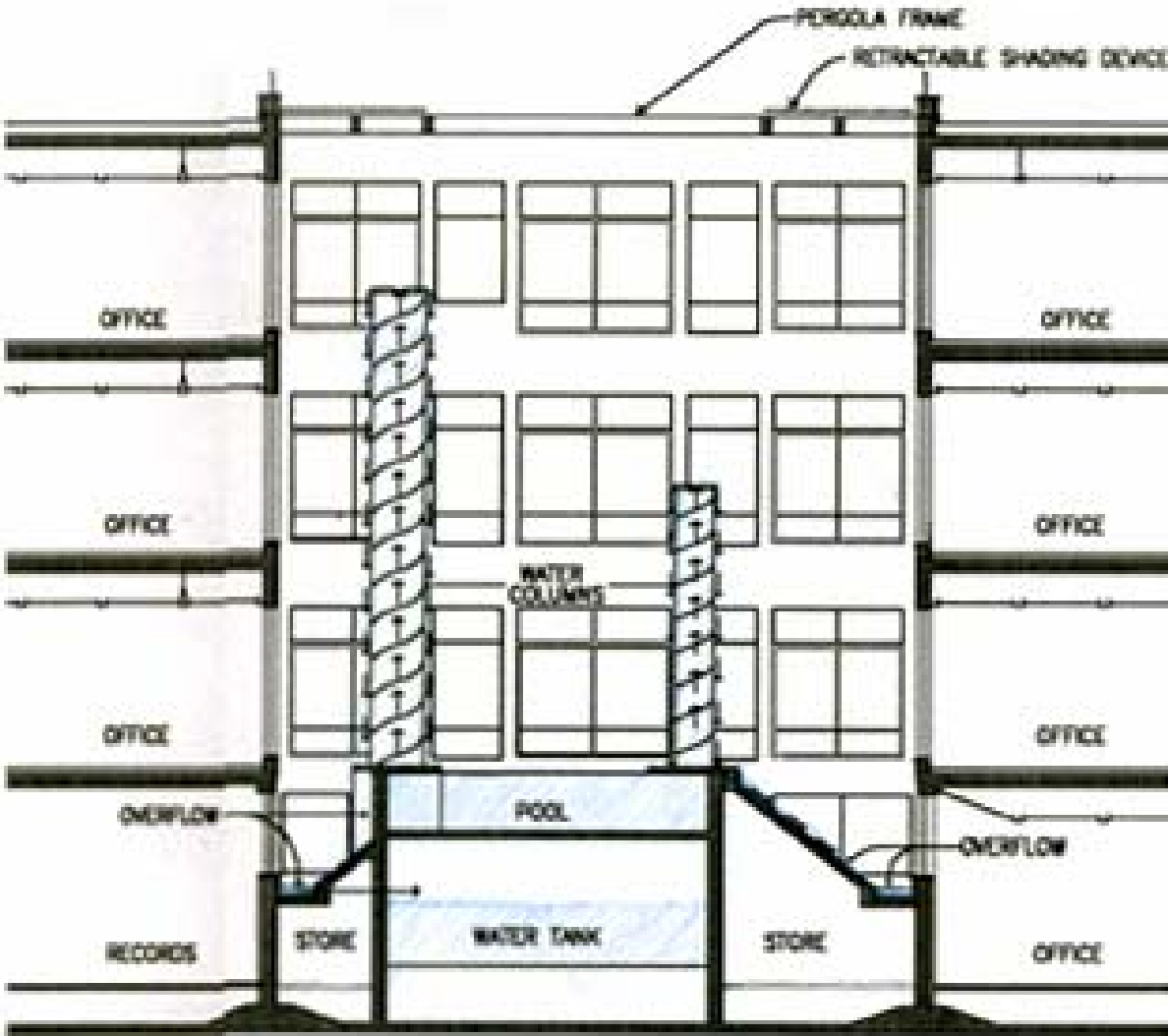
# INTERNAL MICROCLIMATE

## □ FOUNTAIN COURT

- Evaporative cooling
- Psychological comfort in seeing and hearing the play of water



# INTERNAL MICROCLIMATE



FOUNTAIN COURT



# ILLUMINATION

- Design for daylight, reduce electric lighting



- Adequate daylighting throughout from courtyard
- from high window

- Glazed partitions to cabins



- Electric lighting  
(5 watts per sq. m)

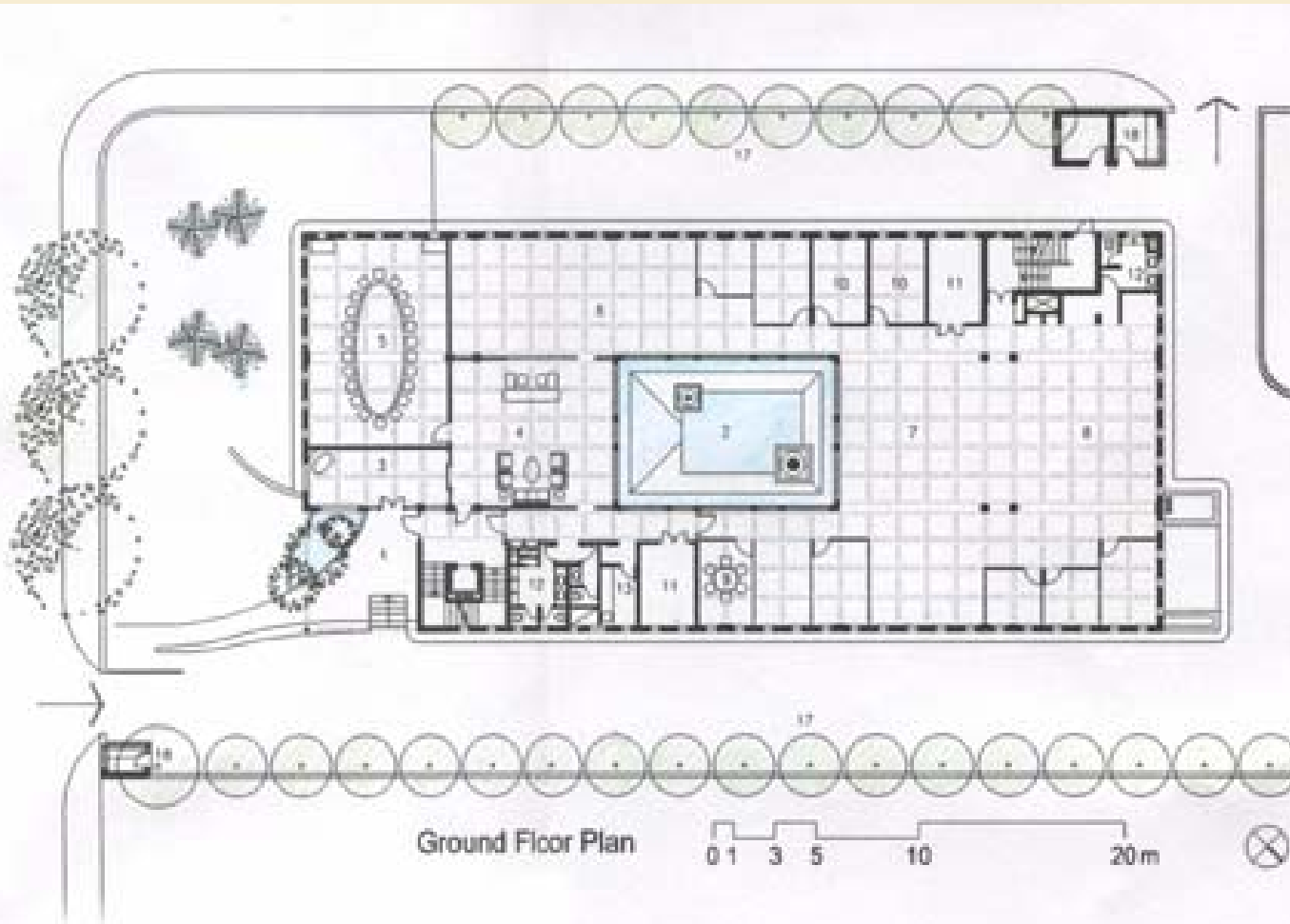
- Supplements daylight
- mostly compact fluorescent lamp
- general illumination level (150 lux)
- use desk lamps where necessary.

# AIR CONDITIONING SYSTEM

- DEFINING COMFORT LEVEL
- ANCILLARY FUNCTIONS NOT AIR CONDITIONED

24°C ± 1 °C

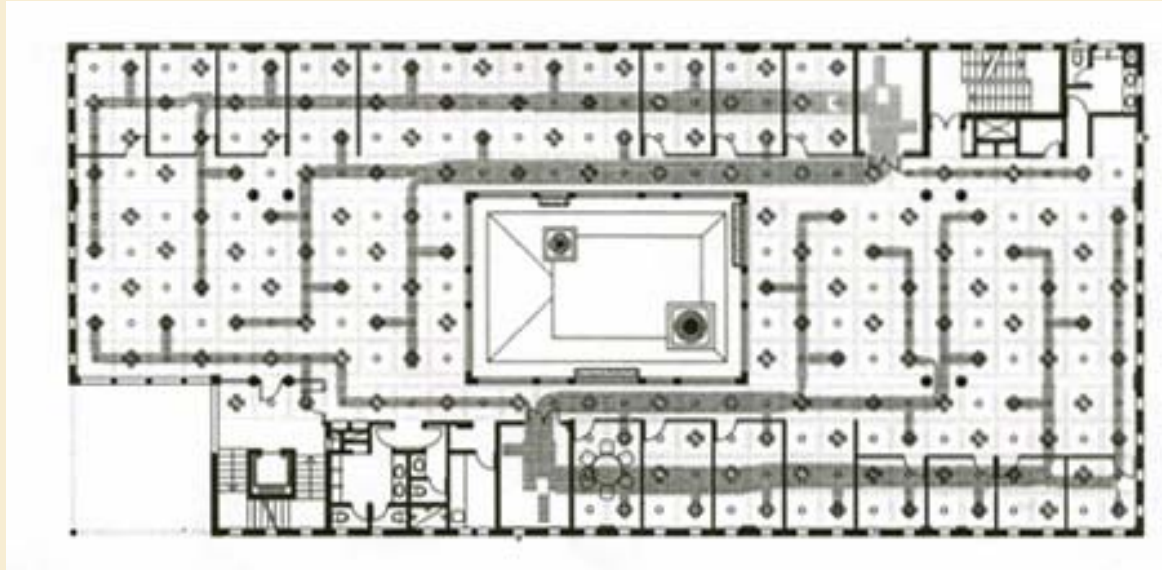
Buffers against the hottest corners of the building. Mechanical ventilated drawing conditioned air from neighboring spaces.



# AIR CONDITIONING SYSTEM

## □ DISTRIBUTION

*plan for flexibility in forming cabins*



□ **HEAVY MASS- FLOORS, SLAB, WALLS IN CONTACT WITH CONDITIONED AIR FLOW**

□ **POSSIBILITY OF USING FRESH AIR DURING COOL DAYS IN EARLY WINTERS**

□ **POSSIBILITY OF NIGHT VENTILATION IN AUTUMN/ SPRING**

*Fresh air intakes are sized for 100% Intake (could be automated).*

*Store coolth in structure to reduce air-conditioning requirement.*

# PERFORMANCE REVIEW

- CHOICE OF CHILLER PLANT  
Absorption chiller- diesel fired  
convertible to gas

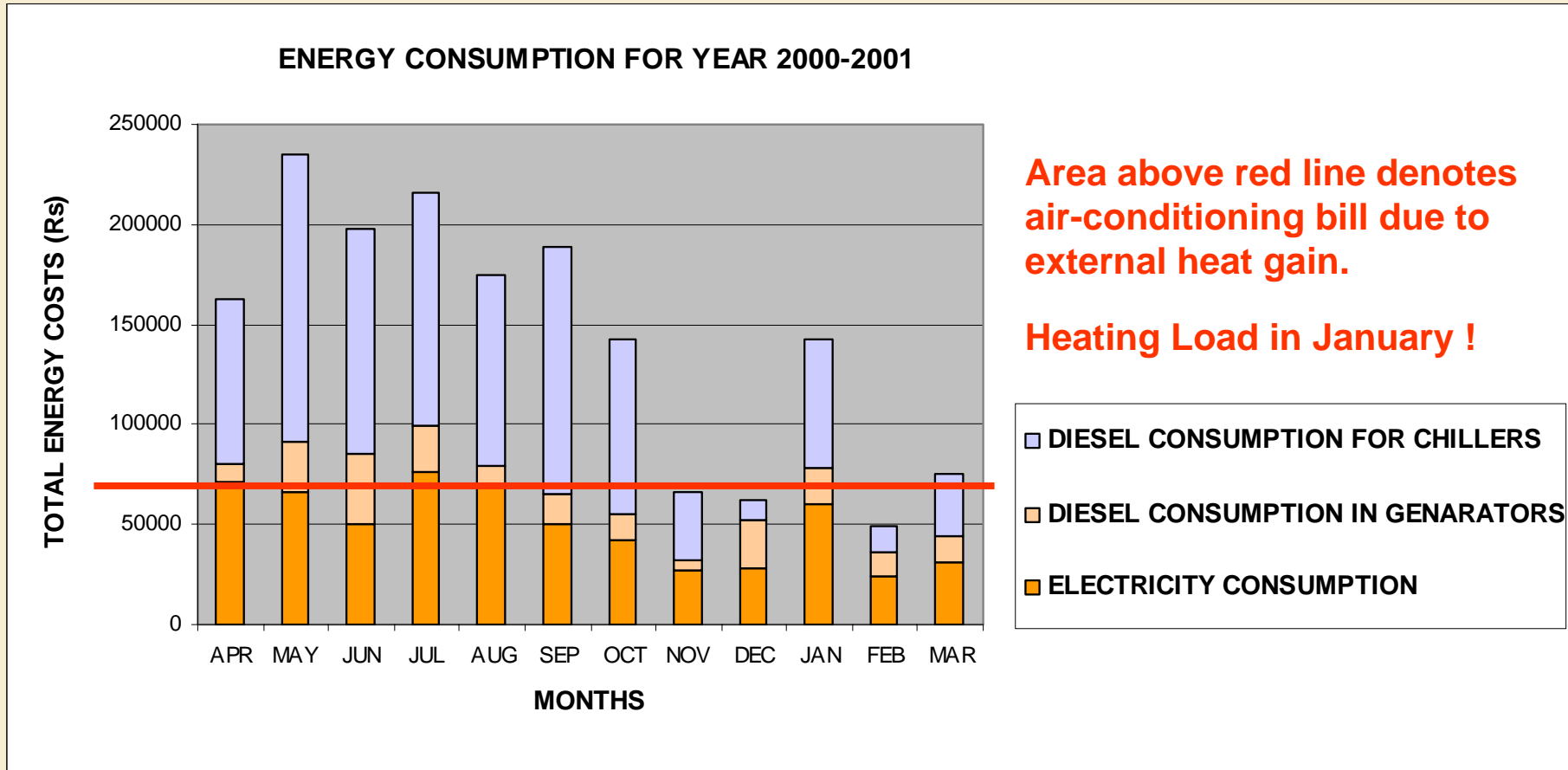
Uncertain electricity supply at present, possibility of piped natural gas.

## INSTALLED AIRCONDITIONING CAPACITY

|                                 |                    |                                 |                |
|---------------------------------|--------------------|---------------------------------|----------------|
| - <i>selected chillers</i>      | <i>2 x 63 TR</i>   | - <i>designed peak load</i>     | <i>117 TR</i>  |
| - <i>gross floor area</i>       | <i>29,500 sft</i>  | - <i>served area (gross)/TR</i> | <i>252 sft</i> |
| - <i>conditioned floor area</i> | <i>22,200 sft</i>  | - <i>served area (net)/TR</i>   | <i>190 sft</i> |
| - <i>designed occupancy</i>     | <i>325 persons</i> | - <i>occupants/TR</i>           | <i>2.7</i>     |
| - <i>current occupancy</i>      | <i>200 persons</i> |                                 |                |
| - <i>actual peak load</i>       | <i>???</i>         | -                               |                |

# PERFORMANCE REVIEW

## ENERGY CONSUMPTION



*Average energy bill per month*

*: Rs. 4.83/sft*

*Average air-conditioning bill per month*

*: Rs. 2.9/sft*

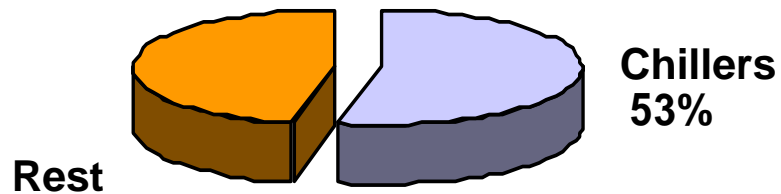
# PERFORMANCE REVIEW

## ENERGY CONSUMPTION

*Average energy bill per month* : Rs. 4.83/sft

*Average Chiller fuel bill per month* : Rs. 2.57/sft

### CHILLER'S SHARE OF TOTAL ENERGY COST





# PERFORMANCE REVIEW

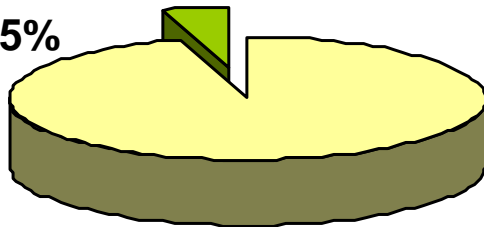
## ADDITIONAL CIVIL WORKS COST

|                                 |                        |
|---------------------------------|------------------------|
| <i>Double Window</i>            | <i>: Rs. 1,90,000</i>  |
| <i>Roof and Wall insulation</i> | <i>: Rs. 8,60,000</i>  |
| <i>Fountain pool</i>            | <i>: Rs. 4,50,000</i>  |
| <b>TOTAL</b>                    | <b>: Rs. 15,00,000</b> |

**OVERALL CIVIL COST : Rs. 3,30,00,000**

### ADDITIONAL CIVIL WORKS SHARE

Additional civil works 5%



Basic civil works 95%

# OBSERVATIONS

- AIR CONDITIONING IS STILL AN EXPENSIVE TECHNOLOGY TO INSTALL AND TO RUN.
- THIS COST IS LARGELY A RESULTANT OF HEAT TRANSFER THROUGH THE BUILDING FABRIC.
- TO MAKE AIR CONDITIONING MORE AFFORDABLE, THE MOST EFFECTIVE STRATEGY IS

*TO DESIGN THE BUILDING FABRIC ITSELF TO MINIMISE AIR CONDITIONING LOAD.*

*THIS IS EFFECTED AT MARGINAL EXTRA COST OF INSULATION AND SHADING.*

**WE LOOK FORWARD TO THE COMMUNITY OF ARCHITECTS AND AIR CONDITIONING ENGINEERS ADOPTING PERFORMANCE BENCHMARKS FOR VARIOUS KINDS OF BUILDINGS FOR VARIOUS CLIMATIC ZONES.**