INTERNAL STRUCTURE OF REACTOR BUILDING FOR MADRAS ATOMIC POWER PROJECT

by
D.P. Pandit
Tata Consulting Engineers
Bombay, INDIA.

Presented at the Symposium on Structural Mechanics, Bombay, 20-22 March 1975.

I-SM-4-CS/75

INTERNAL STRUCTURE OF REACTOR BUILDING FOR MADRAS ATOMIC POWER PROJECT

D.P. Pandit

Tata Consulting Engineers

Bombay

Stress Analysis of the internal structure of the Reactor Building is presented in this paper. Two methods of analysis for horizontal loads in the East-West direction are described and the results compared.

I. THE INTERNAL STRUCTURE (Fig 1 and 2)

This structure is enclosed inside the containment of [illegible]' radius and has the following major parts :

1. Structural steel framework of columns, beams and bracings
2. R.C. walls and columns
3. R.C. slabs at various levels

The Calandria Vault Structure, which is in the centre of the Reactor Building, is completely separated from it by providing expansion joint all around it.

1. **Structural Steel Framework** - Structural steel framing consists of steel beams at various floors to support R.C. slabs, steel columns and bracings. The beams are supported by steel columns or R.C. walls or sliding bearings installed in the pockets provided in the containment wall. The use of sliding bearings avoids any transfer of horizontal forces from the internal structure to the containment and

vice versa. The steel bracing system contributes its share of stiffness against horizontal forces. Steel members at El.+72'-4" level tie East and West Cross walls.

2. R.C. Walls & Columns - The East and West cross walls form the major walls supporting the vertical loads and stiffening in the horizontal direction. All R.C. Columns stop or merge in the walls at elevations lower than El.+35'-0. Below El.+35'-0, the North and South walls, as well as the walls under the Calandria Vault, merge with East and West cross walls to form two very rigid boxes. The elevator shaft wall indicated in the idealised frame was relieved of horizontal forces by providing appropriate detailing at a later stage.

3. R.C. Slabs - All slabs are separated by a 3" gap from the containment shell. Most of the slabs have a large number of embedded parts and cutouts. However, they are thick enough not to pose any design problems, except in the boiler room floor.

II. THE ANALYSIS

Analysis of the structure subjected to horizontal forces in the East-West and North-South directions was done.

The following two methods of analysis were adopted for analysis in the East-West direction :

1. Equivalent plane frame analysis (Fig.3)
2. Finite Element analysis for walls (Fig.5)

As it was felt that thick R.C. walls might not pose design problems in the presence of stiff structural steel bracing, an approximate analysis was done to estimate the bending moments in the walls and axial forces in bracings, due to surge and earthquake loading.

The following assumptions were made for plane frame analysis in the East-West direction :

i. The structural steel framework is pin-connected.

ii. The elevator shaft wall is not considered effective against horizontal forces

iii. Grid line (3) is the line of symmetry

iv. Floor slabs are rigid in their own planes

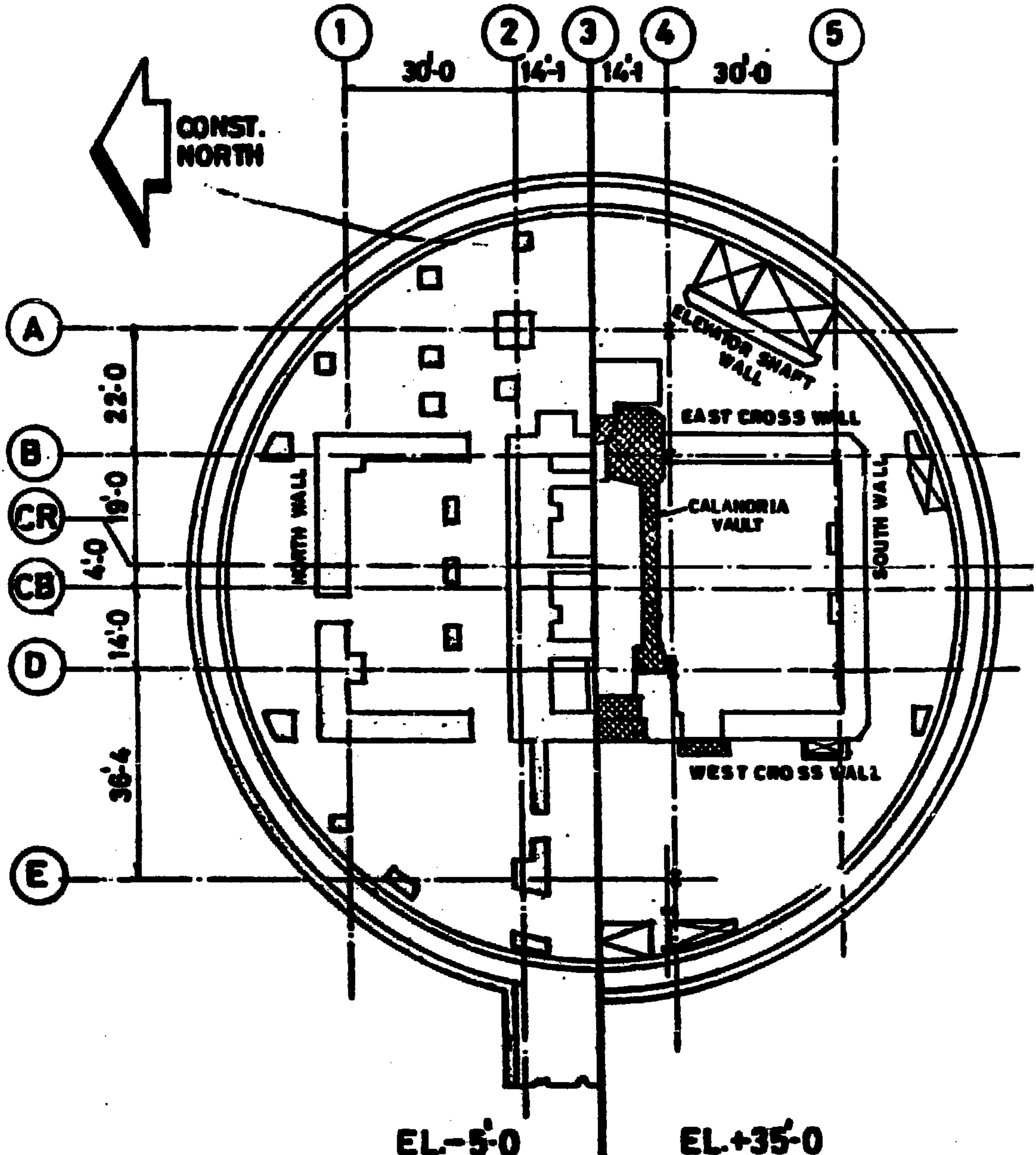
The equivalent plane frame in the East-West direction was idealised to evaluate the interactive forces between the steel and concrete structures. Since the walls were treated in this method as beams, the equivalent moment of inertia of the cross section was established by the use of finite element method with rectangular plate bending elements. By giving unit displacement successively at El.+72'-4 and +110'-4, the total moments at El.+35'-0 were calculated by finite element method. By setting an equivalence, the effective moment of inertia of the wall sections between El.+35'-0 and El.+72'-4" and El.72'-4" and El.+110'-4" were evaluated. The frame was solved by the stiffness matrix method using a computer program

In the second method using finite elements exclusively, the force in tie at El.+72'-4" connecting the two walls was assumed as unknown. By satisfying compatibility at the tie level the final stress resultants were obtained. The effect of the steel bracing system and R.C. walls in the North-South direction were taken into account by providing proper springs in the finite element method.

Analysis of walls for vertical loads was done by using plane stress finite elements.

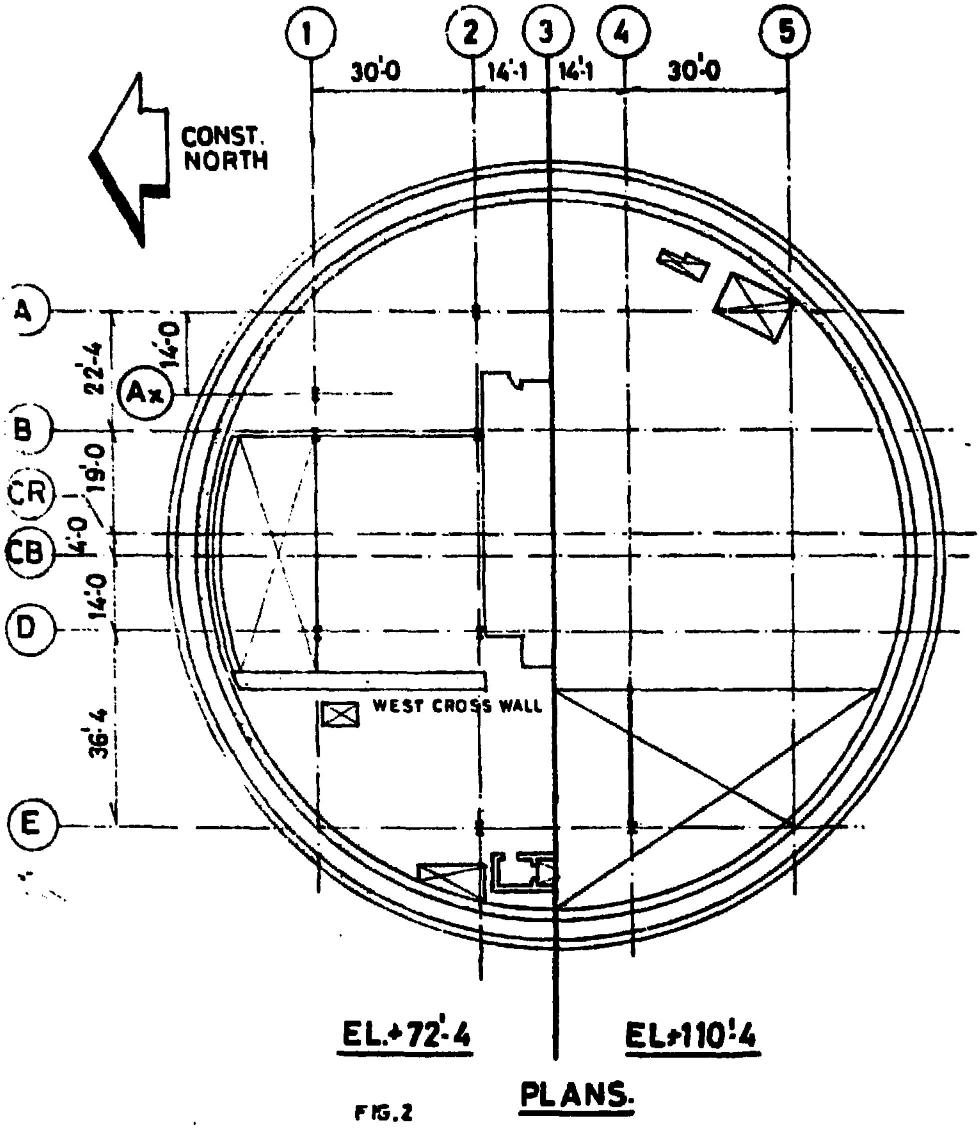
III. [illegible]

The comparison of moments in walls is shown in Fig. 4. The local moments in walls at El.-5'-0 are negligible and increase toward El.+35'-0. The structure is very stiff in North-South direction and there [illegible] not pose any analytical or design problems, whereas it is not as stiff in the East-West direction.


1
2
3
4
5
30'-0
14'-1
14'-1
30'-0
CONST. NORTH
A
B
CR
CB
D
E
22'-0
19'-0
4'-0
14'-0
36'-4
ELEVATOR SHAFT WALL
EAST CROSS WALL
CALANDRIA VAULT
NORTH WALL
SOUTH WALL
WEST CROSS WALL
EL.-5'-0
EL.+35'-0

PLANS.

FIG.1



1
2
3
4
5
30'0
14'1
14'1
30'0
CONST. NORTH
A
Ax
B
CR
CB
D
E
22'4
14'0
19'0
4'0
14'0
36'4
WEST CROSS WALL
EL.+72'-4
EL+110'4
PLANS.

FIG. 2

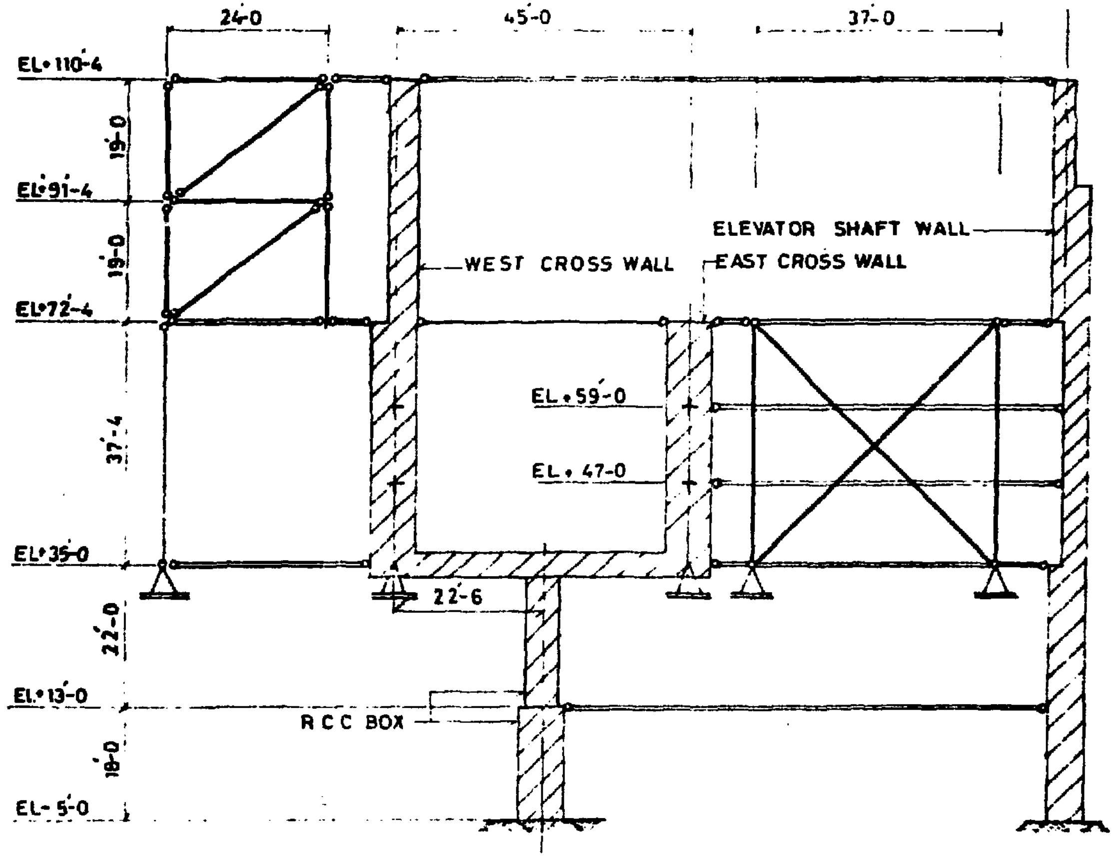
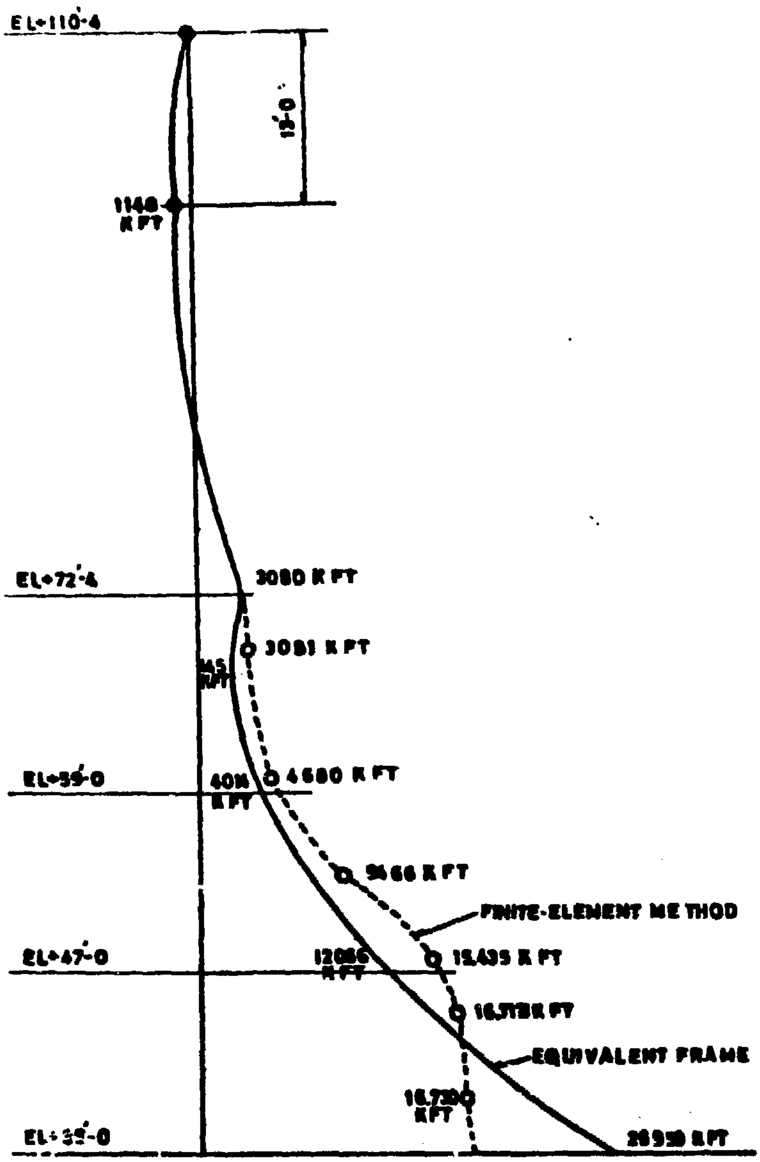


FIG.3 . IDEALISED FRAME FOR INTERNAL STRUCTURE OF REACTOR BUILDING NO 1 & 2

LEGEND
- RIGID SLAB
- STEEL MEMBER
- CONCRETE WALL



BENDING MOMENT DIAGRAM FOR WEST CROSS WALL

FIG.4

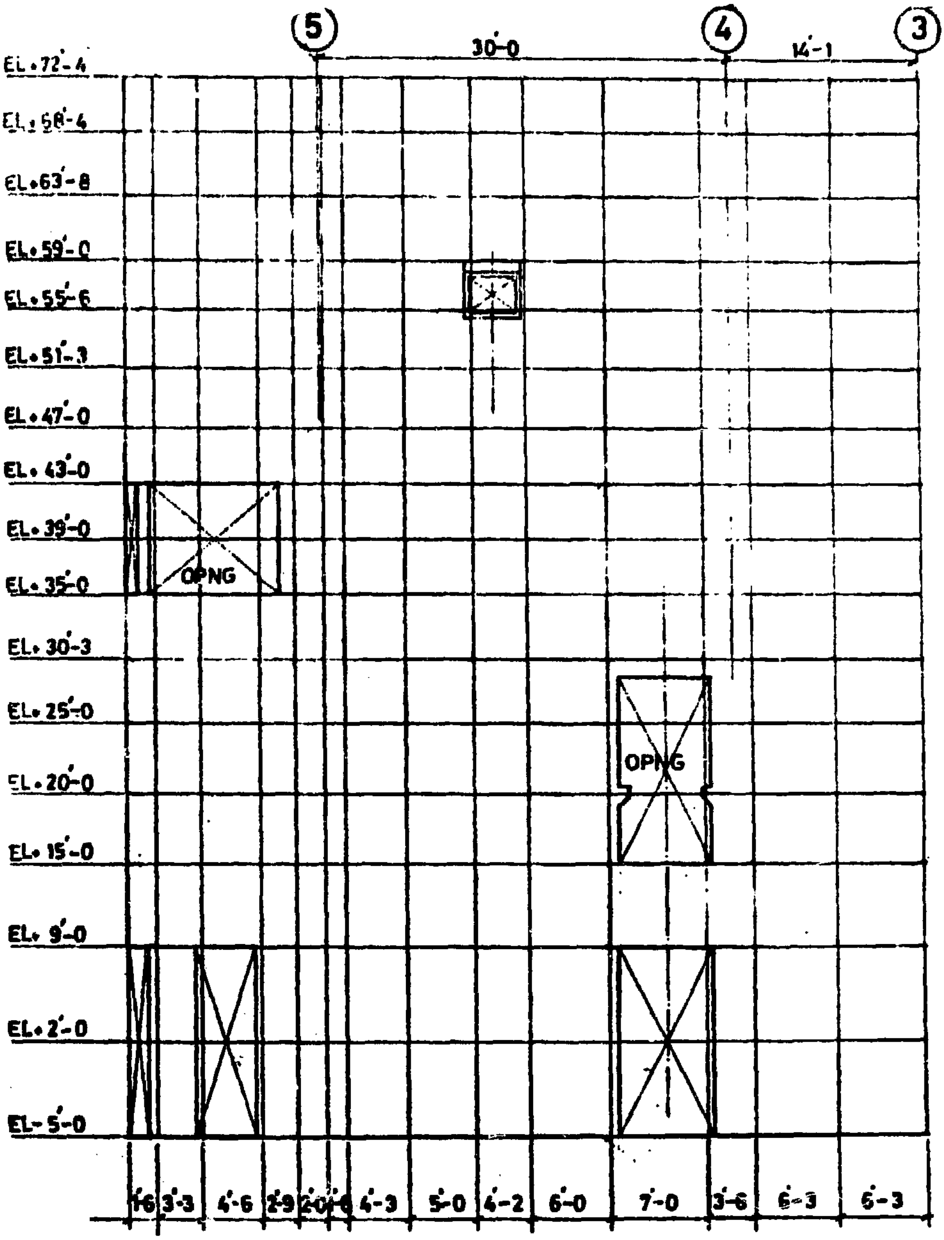


FIG.5

EAST WALL ELEVATION
REACTOR BUILDING NO.1 & 2