USE OF VAULTS AND SOIL TO MINIMIZE SHIELDING COSTS

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The cost of buildings and shielding at accelerator facilities is eating up an increasingly larger fraction of the budget.

This is not only due to the fact that accelerator energies and intensities are dramatically increasing, imposing more stringent demands on the shielding, but also to biological and environmental concerns.

On the biological side, the risk estimates for getting cancer from a given dose are steadily going up, which points to increased shielding in the future.

The same is true for the radiobiological effectiveness of neutrons, which the National Commission on Radiological Protection considers to be increasing by a factor of 2.

Then come the environmental concerns. The Department of Energy limit on the dose to the general public at the fence post is now 100 mrem/year, with a reporting limit of 25 mrem/year and a design goal of 10 mrem/year. This is for how low a radiation level you must shield the facility, in particular its skyshine.

In addition there is the ground water, which has to have less activity than drinking water standards. Therefore one has to pour large quantities of concrete around some buildings, like accelerator sections where losses occur and beam dumps, to prevent neutrons from coming in contact with ground water. Until now accelerator buildings have usually been built with a box type rectangular cross-section. It has the advantages of being standard construction and the walls are strong enough to carry the crane rails.

Large savings can be accomplished by going over to thin shell or vault construction. By curving the structure it becomes more resistant and can be made much thinner. If one can have double curvature, like in a spherical dome rather than in a cylindrical gallery, the savings are even larger and one can go to larger spans. The crane rails cannot now be attached to the structure, but must be placed on steel pillars or truss systems resting on the floor slab.

This type of architecture leads to a whole new configuration of buildings, which relies on earth for shielding, on thin shells for supporting it and on rounded shapes for ensuring structural strength.

There are now new techniques available that permit construction of vaults and domes without having to make expensive wooden or steel forms and the concrete is preferably gunned.

As an example, we will take the patient irradiation rooms of a cancer treatment center operating with a heavy ion beam (figs. 1, 2, 3).

The rooms are circular, which allows them to be covered with thin hemispherical vaults.

The beam tunnels have a semicircular vault resting on a flat slab as floor. This shape permits a smooth, rounded connection to the vaults, avoiding angles, so that the shells flow into one another.

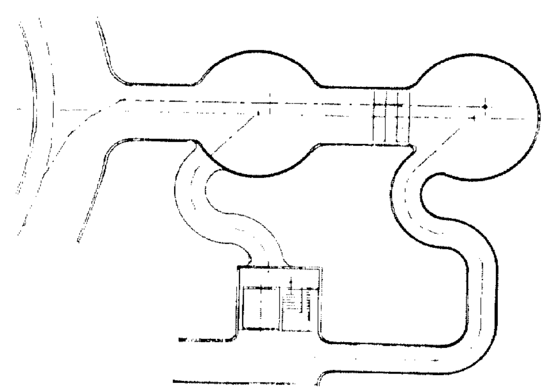

Fig. 1: Plan of Heavy Ions Treatment Rooms

The same is true for the patient access tunnels. These tunnels are also made of thin shells. The use of heavy neutron doors is avoided through S-shaped labyrinths, which connect to a traditional box shaped building housing the patient elevator and stairways.

Three fixed beams are envisioned: one horizontal and two at 60° upwards and downwards. Shielding is provided by layers of soil placed between the upper room and the horizontal beam tunnel and the same tunnel and the lower room.

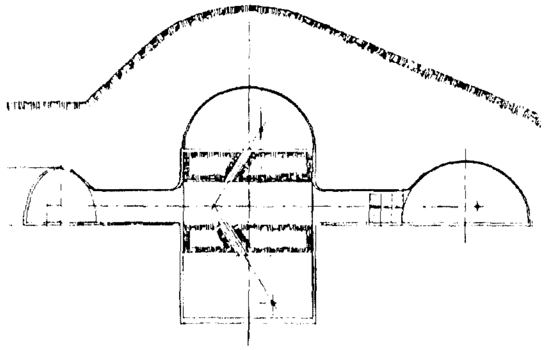

Fig. 2: Longitudinal Section

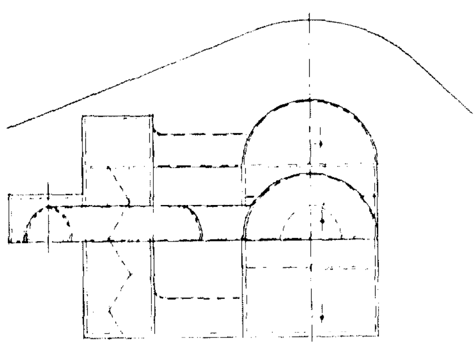

Fig. 3: View from End of Main Beam

It is hoped that one will consider this kind of construction when designing future accelerator facilities.