

Heavyweight Radiation-Shielding Concrete Dammam University Hospital

Heavyweight concrete is primarily used for radiation shielding. Selection of concrete is based on space requirements and intensity of radiation.

The Ministry of Higher Education constructed a hospital at the University of Dammam to provide special medical attention and support to the higher education sector. The project will see the construction of a medical tower 12 stories high, and house 400 beds. Among the rooms constructed at the hospital is a radiation treatment room. The room requires 1,500 m³ of heavyweight concrete with wall thicknesses ranging from 1.40 m to 3.55 m and slab thickness of 1.6 m.

Requirements:

1. Heavyweight concrete for radiation treatment room
2. Compressive strength: 35 MPa
3. Concrete density: 2,800 kg/m³
4. Slag aggregate gradation according to ASTM C537

Challenges:

1. Produce heavyweight concrete with density 2,800 kg/m³
2. Control the heat of hydration in the large concrete sections and avoid the formation of thermal micro cracks.
3. Shield intense radiation.
4. Find the right aggregate locally with required properties, gradation and density. The available slag aggregate in the market is different from the requirements of ASTM C537.

Solutions:

1. Iron based slag (as coarse aggregate) was used for added weight and shielding effect.
2. Several trial mixes were performed using the available slag aggregates to achieve the desired performance specification.
3. A portion of the cement was replaced with supplementary cementitious materials (25% by weight) in the mix to reduce the heat of hydration while maintaining the required strength, and sustainability.

4. Heat of hydration was measured and simulated using special testing devices (illustrated in Figure. 1)



Figure 1: A simple and rapid test device for monitoring the heat of hydration of concrete mixtures for both laboratory and field applications

Concrete Mix Design and Properties:

Mix Design	
Ingredient	Quantity
Cementitious material content	440 kg/m ³
W/C ratio	0.36
Aggregate	1,500 kg/m ³
Sand	735 kg/m ³
Admixture	1.5 l/m ³
Fresh and Hardened Properties	
Compressive strength	35 MPa
Slump	175±40 mm
Density	2,900 kg/m ³

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