Proton beam therapy centre, Manchester

Project case study

Product

Bespoke concrete containing 70% Regen GGBS

Volume

20,000 cubic metres

Client

The Christie NHS Foundation Trust

Contractor

Interserve

Overview

Hanson has supplied the concrete to construct the UK's first proton beam therapy centre at The Christie NHS Foundation Trust in Manchester, one of the largest cancer treatment centres in Europe. This project was also the first to use concrete solely as a shielding medium for proton beam therapy. From early engagement, innovative design to execution, the bespoke concrete mix had to perform on numerous complex levels outside the parameters expected in conventional construction.

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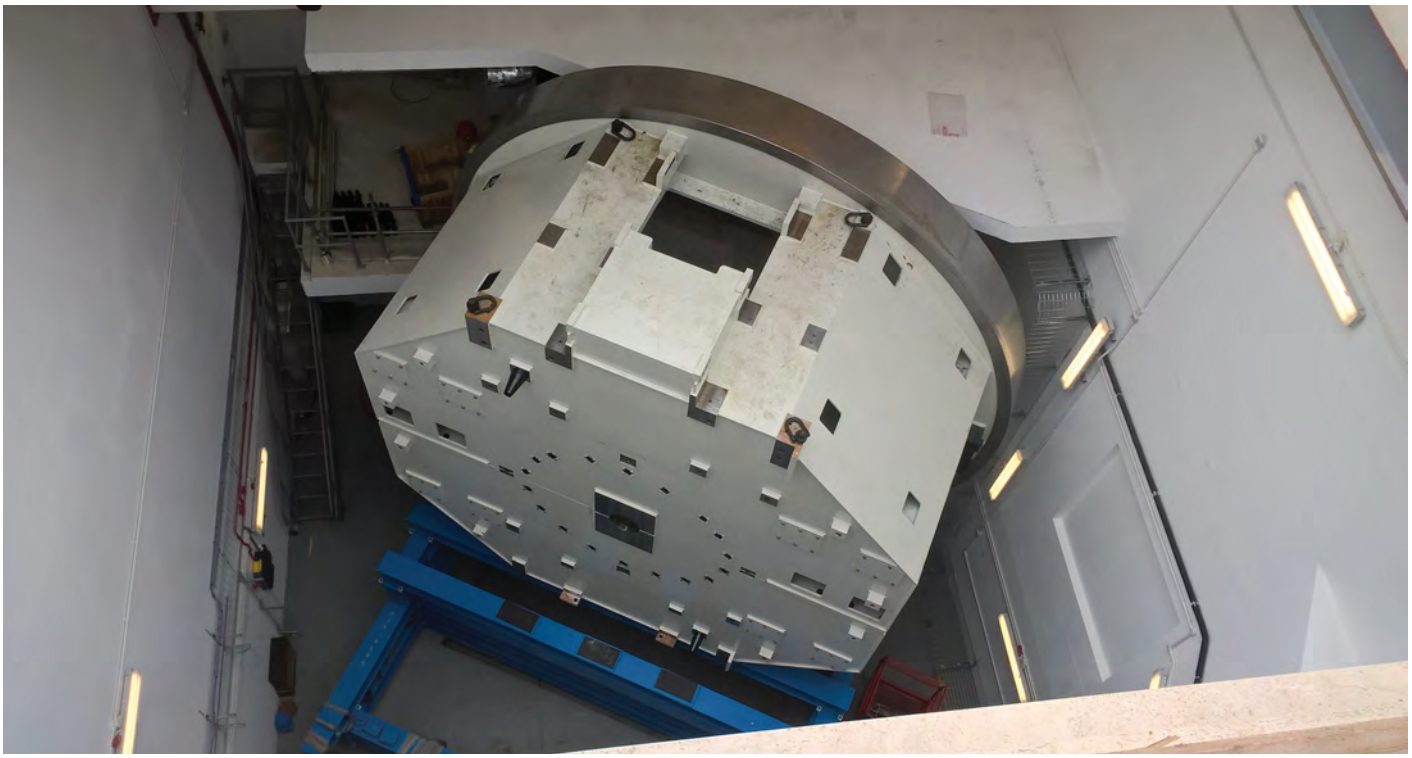
Proton beam therapy centre, Manchester

Cancer treatment facility



Project description

Proton beam therapy is a highly specialised form of radiotherapy, which can precisely target certain inoperable tumours, increasing survival rates and reducing the harmful side effects associated with other cancer treatments.

The therapy uses protons – positively charged particles – accelerated to extremely high speeds, to produce a high energy beam. High energy protons are harmful to those exposed to them over a long period of time, so hospital staff using the equipment must be protected. As a result, it is vital to prevent radiation leakage and therefore a thick concrete barrier is required to separate equipment and hospital staff.

The scale of this aspect of the project was immense, with a requirement for material and skills to deliver the 20,000m^3 concrete pour and 1,700 tonnes of reinforcement over 12 months, accommodating thicknesses between two and six metres. The largest single concrete pour was 700m^3 with the average being 350m^3. In total, more than 100 separate controlled pours were required to complete the construction.

The concrete element of the project relates to two areas: the first is to house three treatment rooms and a research and development room; and the second is to house the "cyclotron", an innovative particle accelerator, the size of a saloon car but weighing the same as a jumbo jet. Included within each of the treatment rooms is a 360^0 gantry and steel structure weighing 180 tonnes requiring a space as tall as a three storey house to allow them to operate.

The highest risks to the success of the shielding concrete for the treatment rooms and cyclotron were thermal cracking and failure to meet the strict density requirement. Both were carefully controlled through early engagement and detailed methodology and will be subjected to ongoing radiation leak testing.

Hanson conducted a full scale test pour to ensure that each pour would be executed right first time, despite variations in ambient temperature throughout the 12 month programme. The pour sequence was also crucial with each needing to be completed during a single working day. A 'joggle joint' was employed to ensure each concrete element locks together securely to prevent radiation leakage at stop ends.

Various specification constraints on the mix composition added to the overall complexity. Although a relatively high concrete density was required, the thermal constraints and coefficient's of thermal expansion limited coarse aggregate type to Carboniferous limestone. In addition, the inclusion of 70 per cent Regen ground granulated blast furnace slag (GGBS), with a maximum specified cementitious content of 355kg/m^3 and a maximum free water cement ratio of 0.40, limited the free water content to only 142l/m^3. The concrete also had to be pumped into the structure within a consistence range of 180 and 220mm, with 200mm being the optimum target.

"In isolation, any of these parameters are not difficult to achieve," said Hanson Concrete technical services manager Terry Balmer. "But, in combination, they presented a number of concrete mix design challenges as many of them are conflicting.

"The rigorous site testing regime ensured deliveries were tested for fresh wet density and consistence before placement and these. The results of both controls were excellent throughout the project and all compressive strength tests were in excess of specification requirements.

"The proton beam therapy centre at the Christie hospital is the largest planned in the UK and is being promoted as best practice for other similar facilities that will be built in the future."