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CHESS upgrade 1995: improved radiation shielding

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The Cornell Electron Storage Ring (CESR) stores electrons and positrons at 5.3 GeV for the production and study of B mesons and in addition, it supplies synchrotron radiation for CHESS. The machine has been upgraded for 300 mA operation. It is planned that each beam will be injected in about 5 minutes and that particle beam lifetimes will be several hours.

In a cooperative effort, staff members at CHESS and LNS have studied sources in CESR that produce radiation in the user areas. The group has been responsible for the development and realization of new tunnel shielding walls that provide a level of radiation protection from 20 to >100 times what was previously available. Our experience has indicated that a major contribution to the environmental radiation is not from photons, but results from neutrons that are generated by particle beam loss in the ring. Neutrons are stopped by inelastic scattering and absorption in thick materials such as heavy concrete.

The design for the upgraded walls, the development of a mix for our heavy concrete and all the concrete casting was done by CHESS and LNS personnel. The concrete incorporates a new material for this application, one that has yielded a significant cost saving in the production of over 200 tons of new wall sections. The material is an artificially enriched iron oxide pellet manufactured in vast quantities from hematite ore for the steel making industry. Its material and chemical properties (iron and impurity content, strength, size and uniformity) make it an excellent substitute for high grade Brazilian ore which is commonly used as heavy aggregate in radiation shielding. Its cost is about a third that of the natural ore.

The concrete has excellent workability, a 28-day com-pressive strength exceeding 6000 psi and a density of 220 lbs/ft^3 (3.5 gr/cc). The density is limited by an interesting property of the pellets which is motivated by efficiency in the steel making application. The pellets are made to be porous, with about 28% of the volume consisting of connected pores of typically size from 1-10 microns. The porosity may have some useful implications for neutron radiation shielding including the possi-bility of holding a lot more water then a conventional mix, and the opportunity to impregnate the pellets with a good neutron absorber such as boron.

This paper will discuss these developments, and report the latest results on the effectiveness of the upgraded shielding at Cornell.