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High-Precision Measurement Method of Accelerator Tunnel Control Network Based on Total Station Angle Observation

Given the importance of accelerator devices, major developed and emerging countries around the world have invested significant human and material resources in the development, construction, and operation of more advanced large-scale accelerator devices. With the development of accelerator technology, the scale of accelerators is becoming larger and larger, ranging from hundreds of meters to several kilometers. For the stable operation of accelerators, high-precision alignment, positioning, and installation are crucial. Currently, the existing tunnel control network measurement method for accelerators is based on laser trackers, which has the disadvantages of low measurement efficiency, high labor and resource costs, and difficulty to achieve automatic measurement. This method slows down the construction period of accelerators at the same time and poses safety risks to personnel who are exposed to the enclosed and radiated environment for long periods of time. Therefore, this study proposes a tunnel control network measurement method using a total station angle observation. By taking advantage of the high precision of angle observation with a total station, only angle observations are used for angle intersection measurement, while different length scale reference conditions are added to constrain the control network to achieve high-precision measurement of the tunnel's 3D control network. In addition, laser trackers require special targets, which are expensive. Total stations do not require special targets and can be remotely measured and automatically measured through the pre-deployment of targets, reducing labor costs and time for personnel. By using the measured results of the designed and deployed control points measured by the laser tracker to simulate the total station angle observations, combined with the length scale values of the length control network measured by the laser range finder, the control network point accuracy of the China Spallation Neutron Source circular accelerator is calculated, and the overall plane point accuracy can reach 66 μm. This method can reduce the time and activity of personnel entering the site and the risk of radiation exposure. For on-site measurement, it can achieve monitoring and remote measurement during operation and provide reference for the installation and measurement of tunnel control networks for large scale accelerators such as Circular Electron Positron Collider (CEPC).

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