

7 - 20 The Deformation Analysis of the 3D Alignment Control Network Based on the Multiple Congruence Models

Zhang Xudong, Chen Wenjun, Zhang Bin, Wang Shaoming, Yuan Jiandong, Sun Guozhen and Zhang Xiaodong

In the construction and maintenance of particle accelerators, all the accelerator elements should be installed in the same coordinate system, only in this way could the devices in the actual world be consistent with the design drawings. However, with the occurrence of the movements of the reinforced concrete cover plates at short notice or building deformations in the long term, the control points upon the engineering structure will be displaced, the fitness between the subnetwork and the global control network may be irresponsible. Therefore, it is necessary to evaluate the deformations of the 3D alignment control network. Different from the extant investigations, in this article, to characterize the deformations of the control network, all of the congruent models between the points measured in different epochs have been identified, and the congruence model with the most control points is considered as the primary or fundamental model, the remaining models are recognized as the additional ones. Furthermore, the discrepancies between the primary S -transformation parameters and the additional S -transformation parameters can reflect the relative movements of the additional congruence models. The iterative combinatorial theory is proposed to detect multiple congruence models in the control network. Considering the actual work of the alignment, it is essential to identify the competitive models in the monitoring network, which can provide us a hint that, even the fitness between the subnetwork and the global control network is good, there are still deformations which may be ignored. The numerical experiments show that the suggested approaches can describe the deformation of the 3D alignment control network roundly (Fig. 1).

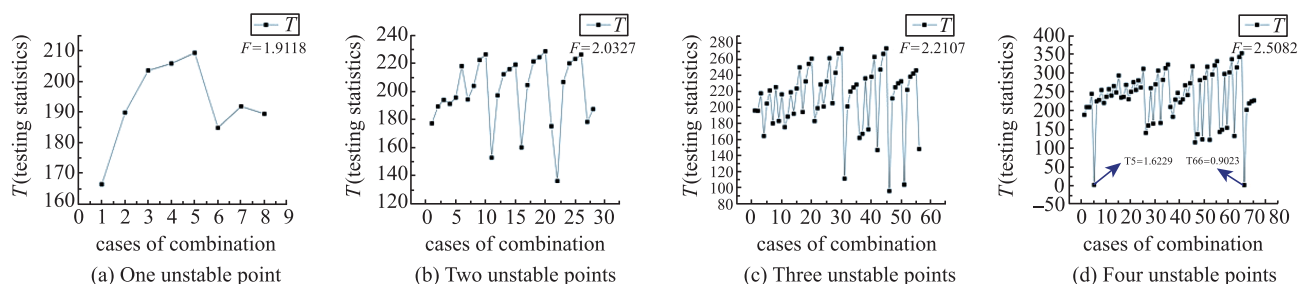


Fig. 1 (color online) (The congruence models got by combinatorial theory) The iterative combinatorial theory is used to detect the congruence models of this situation, owing to the null hypothesis has been rejected. We firstly assume that there is one displaced point, for the seven combination situations as (a), all of the testing statistics are bigger than critical value, that is to say, there are at least two unstable points. As (b), for the combination situations of six points supposed to be stable, all of the testing statistics are smaller than critical value. As (c), or the situations of five points supposed to be stable, there is no congruence model. It is delightful that two congruence models are found in the seventy combination situations as (d), when four points are assumed to be unstable. T5, represents the congruence model which consists of H6, H45, H46 and PB7, and T66, the model made up of H49, H50, H51, H52.

Through the analysis of this research, it can be concluded that: (1) The same movements of the partial control points really exist. For the 3D alignment control network, it is a severe problem, because the fitness of the common points only measured in a single station may not reflect this problem. The laser tracker may be located improperly, and the elements of the accelerator may be adjusted falsely. (2) To avoid this scenario, the 3D global alignment network should be updated every and again, then the work of the alignment is more convincing. (3) For the global alignment control network, the deformations based on the congruence models are more rational than the individual points.