建筑物沉降观测方案的设计与数据分析

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摘　要：概述了位于成都市龙泉驿区龙工南路的蔚蓝花城 13 号楼沉降观测工程基本情况，简单介绍了该楼点位布设及观测周期等情况，其中就基准点的布设和基准网稳定性做了详细论述，并由观测数据结合曲线图分析了该建筑的形变情况并作出相应结论。

关键词：沉降；基准点；数据分析

中图分类号：P258　　**文献标志码**：B　　**文章编号**：1672-4623（2012）01-0146-02

随着社会的不断进步，物质文明的提高以及建筑设计施工技术水平的成熟完善；土地资源日渐减少与人口增长之间的矛盾日益突出，高层及超高层建筑物越来越多。为了保证建筑物的正常使用寿命和建筑物的安全性，并为以后的勘察设计施工提供可靠的资料及相应的沉降参数，建筑物沉降观测的必要性和重要性愈加明显。

1　工程概况

蔚蓝花城位于成都市龙泉驿区龙工南路，住宅楼 30 幢，其中 13 号楼高 24 层，监测工作中共设 3 个水准基点，9 个观测点，观测工作自 2006 年 11 月至 2008 年 9 月，观测历时 45 个月，共观测了 11 个周期。

2　水准网布设及稳定性监测

1）首先建立水准基准网，采用独立高程系，由以下 3 个水准基点构成水准闭合环，每次观测平差后的数据较差均小于高程中误差的 2 倍；并以基准点 BM-1 高程假设为 500 000.000 mm 来推算另外 2 个基准点的高程，见表 1。

表 1　水准基点高程值/mm

点　名	高　程
BM-1	500 000.000
BM-2	500 551.610
BM-3	500 506.527

2）水准基准网、沉降水准网，采用自由网和非自由网的方式，为提高网的内可靠性和外可靠性，又采用了拟稳平差和非自由网平差处理，尽可能地削弱粗差和平差函数存在的模型误差对精度的影响。

3）沉降点的埋设能够反映荷载在空域中的变化。

为提高沉降点的高程精度，于 2006 年 11 月进行了初始值观测后，于 2007 年 7 月对水准基点进行了 1 次检测工作，其检测及稳定分析结果见表 2，每次水准基点稳定性检测工作完成后，及时对非稳定的水准基点的高程值进行修改处理，为观测数据的准确性提供了可靠依据，由表 2 可见各水准基准点是稳定可靠的。

表 2　水准基点可靠性比较分析表

测段	首期高差(2006-8-10)/m	二期高差(2007-1-10)/m	与首期高差差值/mm	较差限差/mm	测量站数
BM1-BM2	0.132 34	0.132 02	-0.32	± 1.4	4
BM2-BM3	0.127 66	0.127 59	-0.07	± 1.4	4
BM3-BM1	0.034 36	0.034 25	-0.11	± 1.4	4

在基准网的基础上建立以 9 个沉降点组成的沉降水准网（见图 1），以基准网为高程起算依据，计算沉降网各点的高程，并以各沉降点第一周期的高程值为起点推算以后各周期的沉降量和沉降速率，由于该网以结点的形式布网和观测，故而平差后的高程中误差较为均匀，对于描述大楼的垂直形变，有了更可靠的精度保证。

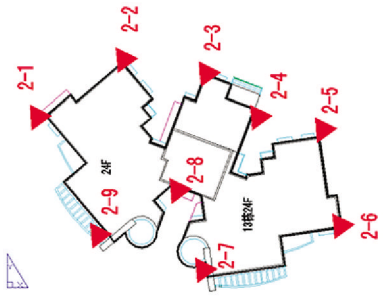

图 1　沉降点布置示意图

收稿日期：2011-06-27
项目来源：科技部国家科技攻关基金资助项目（2005BA901A03）。

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3　监测数据及变形分析

1）2006 年 11 月至 2008 年 9 月观测期间，最大累计沉降量为 6.595 mm（8#观测点），最小累计沉降量为 5.303 mm（6#观测点），最大沉降差为 1.292 mm（6#观测点～ 8#观测点），见表 3。

表 3　各观测点累计沉降量/mm

点　名	累计沉降量
13-1	6.403
13-2	6.465
13-3	5.697
13-4	6.227
13-5	5.744
13-6	5.303
13-7	5.526
13-8	6.595
13-9	5.552

2）在最近 11 个观测周期之间，即 2006 年 11 月～ 2008 年 9 月，时间间隔为 687 d，其平均累计沉降量为 $S_{平}=(S_{13-1}+S_{13-2}+\cdots+S_{13-9})/11=6.001$ mm；平均沉降速度为 $S_{平}/t=6.001$ mm/687d=0.009 mm/d；见表 4。

表 4　各观测点累计沉降速率/mm/d

点　名	累计沉降量
13-1	0.009
13-2	0.009
13-3	0.008
13-4	0.009
13-5	0.012
13-6	0.011
13-7	0.010
13-8	0.008
13-9	0.008

3）沉降量、荷载、时间（S-P-T）关系曲线图（见图 2）分析，从沉降曲线的分布情况来看，所有沉降曲线较集中，表明在观测期间本栋建筑物的基础不均匀沉降现象不显著。

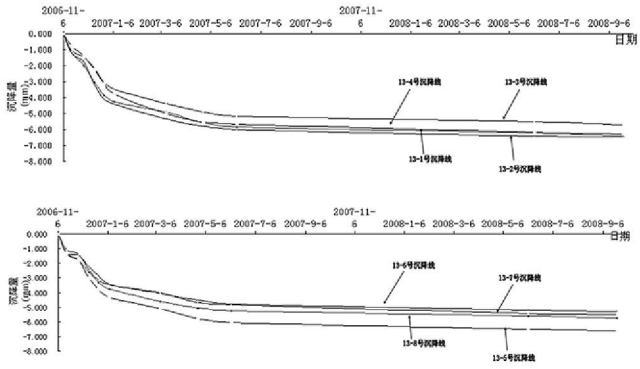

图 2　13 号楼 1-8 号点沉降量曲线图

4　结　语

经过对蔚蓝花城 13 号楼实地观测数据的计算与分析，可作出如下结论：

1）根据对蔚蓝花城 13 号楼 9 个沉降点、11 个观测周期结果来看：大楼随着增高荷载的加重，以及季节而引起的地下水交替变化，各点都在发生着变化，但这些变化趋势，基本一致说明是均匀变化。

2）根据大楼各个方向沉降来看，大楼对地基的压力比较平衡，各沉降点的差异沉降很小，由此看来大楼的整体受力比较均匀。

3）蔚蓝花城 13 号楼的平均沉降速率为 0.009 mm/d，各沉降观测点位的沉降速率均较小，说明基础比较稳固、平衡。

4）各沉降观测点位的累计沉降量均符合规范要求，未见沉降异常。

5）建筑物未发现裂缝等异常。

6）蔚蓝花城 13 号楼平均沉降速率为 0.009 mm/d，达到《建筑变形测量规程》JGJ/T8-97 规范规定：“沉降速率小于 0.01-0.04 mm/d，可认为已进入稳定阶段。”

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other two methods.
Key words remote sensing image fusion, ALOS, land cover, classification (Page:116)

Application of ArcGIS Vector Data Spatial Anslysis in Urban Apartment Selection by YANG Jing

Abstract This study introduced the buffer analysis and overlay analysis in the spatial analysis of ArcGIS vector data. The two spatial analytic capabilities could be utilized to help potential buyers narrow down suitable zones by classify different zones and analyzing the practical situation in choosing apartments in the urban areas.
Key words spatial analysis, buffer analysis, overlay analysis, zone classification (Page:119)

Issues of MapGIS to ArcGIS Data Conversion Process by YANG Xiaochao

Abstract Spatial data conversion is an effective way to increase utilization and reduce duplicate collection of spatial data . Studying the spatial data format conversion can help to significantly improve work efficiency. This paper analyzed the characteristics of MapGIS, ArcGIS software,and explored the problems encountered during the conversion process.It especially analyzed the file corresponding conversion relationship between changes in properties of the field, Figure contour points, and found solutions . It made full use of two complementary advantages of software, so that to maximize sharing of data resources.
Key words MapGIS, ArcGIS, data format conversion (Page:121)

Topographic Map Scanning Digitization and Precision Analysis Based on CASS7.0 by CHEN Nan

Abstract The topographic map scanning digitization is an important acquisition method for GIS data, which has become the mainstream of the map digitization. This article Introduced the scanning digitization's basic principle and the implementation process and with 1:500 existing topographic map for data sources, using professional software CASS7.0 realized the whole production process of the map scanning digitization.It discussed the scanning digital mapping the main error sources and analysed the calibration accuracy and precision of vector in the process of scanning and digitizing.
Key words scanning digitization,gamma correction,precision analysis,CASS7.0 (Page:124)

MapX-based Mine Hydrogeololgy Information Management System by LONG Yang

Abstract This paper expounded the overall design of MapX-based Mine Hydrogeololgy Information Management System, realized the mine hydrogeology data management, maintainance, share and thematic map drawing by using re-development on MapInfo GIS software, the soft offered help to hydrogeology information management work.
Key words MapX, GIS, hydrogeology (Page:127)

Quality Testing Methods of Underground Pipeline Detection Resultsby XIE Zhiqiang

Abstract In the large area underground pipeline detection data checking process , it fully considered the hidden nature of its detection outcomes. We used scientific procedures, standards, sample control, GIS aids scientific and rational means to improve the efficiency of the inspection and ensure the quality of the outcome.
Key words urban underground pipeline detection, quality characteristics, quality assessment, data quality control (Page:129)

Design and Data Analysis of Settlement Observation Based on a New Home Construction in Chengdu by LI Yong

Abstract This paper summarized the new project of Jinniu district, Hou B group (a section of building no. 4) settlement observation engineering basic situation, including the benchmarks laid and detailed discussion of benchmark nets stability, through monitoring data analysis of the building deformation and made corresponding conclusions.
Key words settlement,benchmark,data analysis (Page:132)

Development of Data Processing Systems for Total Station Memory Records Observations by LIU Jiankai

Abstract In the process of traverse field observations, using the electronic record book for total station memory mode, againsting its data logging functions, we made the extract ion of lead observations, the secondary development of computing, and data processing corresponding. Full using of its code measurements function, we developed the data processing module, the extraction of data automatically,and converted them to the standard adjustment file that adjustment software could recognize,reduce labor intensity and the workload of outside the inside.
Key words Traverse,observations,memory record,data processing (Page:134)

Application of Chaotic Theory in Deformation Analysis and prediction by LU Jinjin

Abstract Due to environmental factors and instruments impaction,the deformation monitor can be seen as a complex system, and the parameters are uncertain and randomits, to show the complexity of the nonlinear behavior. The paper used the modern chaotic theory to solve the the time series of monitor deformation, and discussed the chaotic theory and prediction method. The example showed that chaotic time series method can get a better accuracy.
Key words deformation monitoring,chaotic time series,prediction (Page:137)

Application Experiment of SmartStation to Cadastral Inventory Based on the Second Investigation of National land by MEI Xiaodan

Abstract Taking the cadastral inventory of the Sanchahe town in Fuyu county as an example, this paper discussed the application of Leica's SmartStation in cadastral inventory based on the second investigation of national land.By compared the model of Leica's SmartStation without control points with the normal mapping model in accuracy and efficiency,it came to a conclusion that the former was a best way to improve the operational efficiency measurement in field survey .At the same time,this experiment was general and portable ,which had a certain importance to make further promotion in the field and space of super-station instruments.
Key words the second investigation of national land, SmartStation, cadastral inventory, accuracy assessment,the mode of location and measurement (Page:139)

Analyze Chaos of Deformation Monitoring Data by YUAN Changmao

Abstract This paper described the Lyapunov index method and the correlation dimension method of deformation data, and discussed the calculation of deformation monitoring data Lyapunov exponent and correlation dimension. Finally, it showed a practical example with dam observation data.
Key words deformation monitoring, chaos, Lyapunov exponent, correlation dimension, phase space reconstruction (Page:142)

Design and Data Analysis of Settlement Observation of Construction by YANG Jianrong

Abstract This paper summarized basic situation of settlement observational engineering which located in longquanyi district south road of

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blue dragon work city building no. 13, introduced the layout and observation period to make the point, including benchmarks laid and benchmark nets stability do detail, and the observation data with the building of the graph analysis of deformation and made corresponding conclusion

Key words settlement, benchmark, data analysis (Page:146)

Application of Optical Collimation Surveying Technique in Industrial Surveying System by QIN Jie

Abstract In the precision engineering measurement, manufacturing and installation of large equipment , make a higher request about measurement. Through research of technology about plane mirror collimate and cube mirror collimate, this paper used MetroIn system establishment or restoration of high precision of coordinate system, achieved the purpose of manufacturing and installation high precision equipment. This method became one of the key research direction about the field of precision engineering measurement.

Key words theodolite, cube mirror collimate, plane mirror collimate (Page:148)

Contour Application in the Formation of Special Landscape Earthwork Calculation Database by GUI Xiaomei

Abstract Combined with a detailed example of earthworks, it described how to use the contour in the formation of special landscape earthwork calculation database applications.The method exploited the contour could quickly generate a lot of elevation characteristics of the database to encrypt a particular landscape (such as shrimp ponds, fish ponds, etc.) of elevation, making the value of earthwork estimates closer to actual value, assuring earth-moving calculation accuracy and improving efficiency.

Key words contour, the special relief, earthwork calculation, database, CASS software (Page:151)

Establishment of Digital Elevation Model Based on Rules Grid by SHEN Yingzheng

Abstract The digital elevation model based on rules grid and the irregular triangle network digital elevation model are two kinds of main structure. Based on rules grid digital elevation model (DEM) modeling principle and method, this paper analyzed the influence, and established DEM precision established model, realized the algorithm. The results showed that point-by-point admixture-frequency syntheses was very flexible, high efficiency, interpolated accuracy

Key words digital elevation model, spatial interpolation, precision (Page:153)

Application of GIS Data in the Visualized Expression of Thematic Maps by YAN Bin

Abstract On the basis of the relationship between GIS data and map expression and the conflict between them, this paper combined mapping for forestry planning, and proposed the idea that the construction of data selection system and classification system of map expression tier, and the integration of analysis and mapping could achieve the fusion of GIS data and map expression and improve thematic mapping.

Key words GIS data, map expression, mapping for forestry planning, tier of map expression (Page:155)

Concept of Standardizing Large Scale Topographic Map Division and Code by CHEN Zhiyao

Abstract Based on the analysis and comparison of existing national-scale topographic maps and large-scale topographic map division and code, this paper present a new large-scale topographic map division and code method suit for nationwide scope. According to the relationship between the map division code and geographic coordinates, it also gave examples to explain two common applications.

Key words large scale, topographic map, map division and code, standardizing (Page:158)

Design and Call of TrueType Point Symbol Library by FENG Jianqing

Abstract Geographic information software now can not meet the requirements of the drawing. This article described point symbol on the CorelDraw software platform with designing methods and production techniques in detail, combined with FontCreator software packaging symbols to compile point symbol library. According to this method , users can create maps of various point symbol library based on the actual needs of them, by calling TrueType symbol used in the actual project.

Key words cartographic technology, CorelDraw, FontCreator, map symbols, design, TrueType (Page:161)

Design of Automatic Thematic Map Making of Oceanic Observation Data Based on ArcEngine Developing Environment by CAO Lijuan

Abstract Takeing the atmospheric and oceanographic data for instance, this paper expatiated based on ArcEngine developing environment, according to different subject load the ArcGIS cartography template dynamically, extracted and calculated data from spatial database, and modified the attributes of template by each subject, further realized the automatic batch thematic map making function of oceanic observation data.

Key words ArcEngine, cartography template, thematic map (Page:164)

1∶50 000 Database Downsizing Update Technical Process by LI Wenqian

Abstract This paper introduced the operation procedure of 1:50 000 database downsizing update process. It focused on the technical process of 1:10 000 to 1: 50 000 topographic features downsizing update production. Combined with the application of key technology, it put forward to optimized operation technology process. It can play a multiplier effect to improve the efficiency of database downsizing update.

Key words 1:50 000 database, update of downsizing, operation procedure, discussion (Page:169)

Construction and Reform on Graduate Course of Image Processing and Analysis by JIA Yonghong

Abstract Image Processing and Analysis, since it won boutique graduate courses of Wuhan University in 2006, is the first general education course opened by school of remote sensing information and engineering school for the whole graduate students of surveying and mapping. The consctruction and reform about teaching content, teaching materials, teaching methods and means, cyber source were carried by curriculum group. Its achievement had being used in the teaching practice and had obtained the fine teaching effect.

Key words Image Processing and Analysis, course consctruction, teaching reform, general course (Page:171)

Research on the Improvement of Surveying and Mapping Geographic Information Legality Construction by SU Kan

Abstract This article pointed out the main problems in the construction of laws and regulations about the Surveying and mapping geographic information. It also put forward the countermeasure to strengthen the construction of laws and regulations about Surveying and mapping geographic information.

Key words mapping geographic information legislation, legal construction, legal consciousness (Page:173)

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