

建筑物沉降监测设计与实践

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摘要: 阐述了建筑物沉降监测的方案设计过程, 以成都市将军碑建筑模板有限公司研发楼为例, 进行了水准基点稳定性分析, 结合成果表对观测数据做了详细统计分析, 并得出相应结论。

关键词: 沉降监测; 基准点; 稳定性

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目前, 主要的工程建筑物得变形监测在设计阶段就开始考虑了, 设计单位在进行工程设计的同时, 对工业与民用建筑物做出相应的变形监测设计, 然后在建筑物的施工及运营期间进行定期观测, 以保证建筑物安全^[6]。

1 变形观测方案设计

1.1 建筑物变形观测基本流程

1) 筹备阶段。设计单位要编写一个实施观测工作的技术任务书, 其中包括水准标石和沉降标志的布设方案, 确定沉降的相对精度指标及观测周期和观测期限。承担观测工作的测量单位要根据技术任务书编写测量工作计划, 计划必须包括: 水准标石的布设略图及其类型、沉降标志的结构及其固定方法、水准测量线路略图、精度估算和观测方法以及平差计算方法^[1]。

2) 外业布点、观测及成果处理。工作计划确定后, 就要埋设高程控制标志和沉降标志。在测区建立高程控制之后, 开始建筑物的沉降观测, 在一期外业观测结束之后, 要编绘标有水准标石和沉降标志之间的高差和距离的水准路线略图, 计算闭合环的闭合差^[7]。如果闭合差在限差之内, 则可以对线路进行平差, 评定外业观测精度, 并计算沉降速度。

3) 建筑物沉降和地基相对变形的确定。最后的工作是编制每期沉降量、荷载、时间(S-P-T)关系曲线图分析表, 形成最终沉降量统计表, 编写沉降技术报告书等。

1.2 观测网点的布设方案

1) 对于建筑物较少的测区, 宜将控制点连同观测点按单一层次布设; 对建筑物较多且分散的测区, 宜按2个层次布网, 即由控制点组成的控制网、观测点与所联测的控制点组成的扩展网。

2) 应该有至少3个水准基点, 可选择稳定性较好的水准基点作为常用点和检核点。

3) 水准点间距一般15 m-20 m, 沿建筑物四角, 纵横墙的交接处和伸缩缝两侧布置, 且和建筑物轴线平行(或垂直)。

4) 一般情况下, 基准点应与附近的国家水准点联测, 只有当水准点较远时, 才可以采用独立的假定高程系统, 所有的水准基点起算数据要统一平差, 组成统一的变形监测网。

5) 单独建筑物至少布设3个水准点, 以便相互检核。

6) 应避开交通干道、地下管线、松软填土、振动区等易遭受腐蚀和破坏的地点^[2]。

1.3 变形观测成果的精度评定

1981年国际测量联合会提出, 如果观测目的是为使变形值不超过某一允许数值而确保建筑物安全, 则其观测中误差应该小于容许变形值的1/10-1/20; 如果目的是研究其变形过程, 那么中误差应该比这个(1/10-1/20)小的多^[3]。

1.4 需要遵循的原则

一般沉降观测都首先要遵循“五定”原则: 沉降观测的基准点、工作基点和被观测物上的沉降监测点要稳定; 所用仪器、设备要固定; 观测人员要固定; 观测时的环境条件基本一致; 观测路线、镜位、程序和方法要固定^[4]。

2 工程应用

2.1 工程概况

成都市将军碑建筑模板有限公司研发楼位于成都市龙潭寺龙港钢材市场旁, 为5层U型办公楼, 监测工作中共设3个水准基点, 16个观测点, 观测历时8个月。

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2.2 水准基点的设立及检测

水准基点是整个观测工作的基准，为保证观测值

的高可靠性^[5]，在施工区附近（变形区外）共设了供沉降观测使用的 3 个水准基点（BM1 ~ BM3）。

表 1 水准基点可靠性比较分析表

测 段	首期高差/m (2008-12-20)	二期高差/m (2009-4-16)	与首期高差差值/mm	较差限差/mm	测量站数
BM1-BM2	0.152 64	0.152 02	-0.62	± 1.4	4
BM2-BM3	0.127 59	-0.127 63	-0.04	± 1.4	4
BM3-BM1	0.024 36	0.024 26	-0.10	± 1.4	4

高程系统为独立高程系，由以上 3 个水准基点构成水准闭合环，于 2008 年 12 月 20 日进行了初始值观测后，于 2009 年 4 月 16 日对水准基点进行了 1 次检测工作，其检测及稳定分析结果见表 1，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 1 可见各水准基准点稳定可靠。

2.3 基准点与观测点的布设

根据该建筑物的结构、地基及荷载特点并结合有关规范要求，在施工区附近（变形区外）共设了供沉降观测使用的 3 个水准基点（BM1 ~ BM3），变形区内设置 16 个沉降观测点，观测点具体位置见图 1。

2.4 沉降数据统计分析

从表 2 可以看出：

1) 2008 年 12 月 20 日 ~ 2009 年 10 月 19 日观测期间，最大累计沉降量为 4.54 mm（5#观测点），最小累

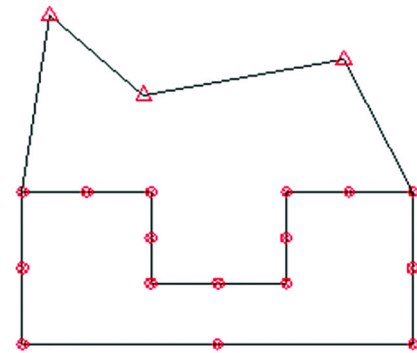


图 1 点位布置示意图

计沉降量为 2.85 mm（1#观测点），最大沉降差为 1.69 mm（1#观测点 ~ 5#观测点），平均累计沉降量为 3.39 mm。

2) 在最近 3 个观测周期之间，即 2009 年 6 月 17 日 ~ 2009 年 10 月 13 日，时间间隔分别为 118 d，其平均沉降量为 0.36 mm，平均沉降速度分别 0.003 mm/d。

表 2 观测成果表

测点	第 1 周期(08.12.20)		第 2 周期(09.1.15)		第 3 周期(09.3.17)		第 4 周期(09.5.21)	
	高程/m	累计沉降量/mm	高程/m	累计沉降量/mm	高程/m	累计沉降量/mm	高程/m	累计沉降量/mm
1#	500.312 21	0.000	500.311 44	-0.770	500.311 11	-1.100	500.310 34	-1.870
2#	500.274 13	0.000	500.273 50	-0.630	500.272 60	-1.530	500.271 83	-2.300
3#	500.277 22	0.000	500.276 56	-0.660	500.275 71	-1.510	500.275 06	-2.160
4#	500.242 57	0.000	500.241 88	-0.690	500.241 13	-1.440	500.239 82	-2.750
5#	500.311 53	0.000	500.310 97	-0.560	500.310 20	-1.330	500.308 57	-2.960
6#	500.270 24	0.000	500.269 49	-0.750	500.269 32	-0.920	500.268 10	-2.140
7#	500.300 21	0.000	500.299 63	-0.580	500.298 76	-1.450	500.297 83	-2.380
8#	500.329 33	0.000	500.328 62	-0.710	500.327 55	-1.780	500.326 67	-2.660
9#	500.266 53	0.000	500.266 04	-0.490	500.265 42	-1.110	500.264 62	-1.910
10#	500.315 84	0.000	500.315 20	-0.640	500.314 34	-1.500	500.313 43	-2.410
11#	500.400 22	0.000	500.399 81	-0.410	500.399 03	-1.190	500.398 23	-1.990
12#	500.305 71	0.000	500.305 10	-0.610	500.303 83	-1.880	500.303 24	-2.470
13#	500.340 32	0.000	500.339 79	-0.530	500.339 21	-1.110	500.338 39	-1.930
14#	500.321 44	0.000	500.320 74	-0.700	500.319 52	-1.920	500.318 75	-2.690
15#	500.359 74	0.000	500.359 33	-0.410	500.358 36	-1.380	500.357 66	-2.080
16#	500.301 15	0.000	500.300 49	-0.660	500.299 57	-1.580	500.298 80	-2.350

测点	第5周期(09.6.17)		第6周期(09.7.24)		第7周期(09.8.14)		第8周期(09.10.13)	
	高程/m	累计沉降量/mm	高程/m	累计沉降量/mm	高程/m	累计沉降量/mm	高程/m	累计沉降量/mm
1#	500.309 78	-2.430	500.309 55	-2.660	500.309 37	-2.842	500.309 36	-2.850
2#	500.271 31	-2.820	500.271 22	-2.910	500.271 05	-3.078	500.270 99	-3.143
3#	500.274 36	-2.860	500.274 19	-3.030	500.273 87	-3.350	500.273 64	-3.580
4#	500.239 05	-3.520	500.238 81	-3.760	500.238 71	-3.858	500.238 57	-4.005
5#	500.307 45	-4.080	500.307 32	-4.210	500.307 08	-4.449	500.306 99	-4.540
6#	500.267 53	-2.710	500.267 43	-2.810	500.267 28	-2.960	500.306 99	-4.540
7#	500.296 75	-3.460	500.296 57	-3.640	500.296 51	-3.703	500.267 20	-3.044
8#	500.325 68	-3.650	500.325 62	-3.710	500.325 55	-3.780	500.296 44	-3.767
9#	500.263 87	-2.660	500.263 68	-2.850	500.263 59	-2.939	500.263 52	-3.007
10#	500.312 42	-3.420	500.312 27	-3.570	500.312 22	-3.617	500.312 03	-3.810
11#	500.397 05	-3.170	500.396 91	-3.310	500.396 79	-3.434	500.396 64	-3.580
12#	500.302 13	-3.580	500.302 00	-3.710	500.301 89	-3.819	500.301 84	-3.870
13#	500.337 47	-2.850	500.337 36	-2.960	500.337 32	-2.999	500.337 29	-3.035
14#	500.317 52	-3.920	500.317 27	-4.170	500.317 09	-4.354	500.316 98	-4.460
15#	500.356 36	-3.380	500.356 25	-3.490	500.356 01	-3.730	500.355 98	-3.760
16#	500.298 03	-3.120	500.297 93	-3.220	500.297 86	-3.289	500.297 79	-3.360

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。

从沉降曲线的沉降趋势来看,2009年4月以后所有沉降曲线开始逐渐趋缓,表明建筑物物体在2009年6月上旬以后开始逐步进入稳定沉降阶段。

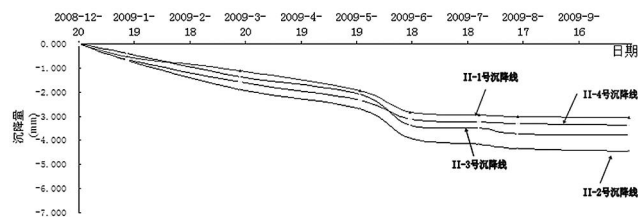


图2 1-4号点沉降量曲线图

3 结 语

1) 根据对成都市将军碑建筑模板有限公司研发楼16个沉降点8个观测周期结果来看,随着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) 根据建筑各个方向沉降来看,建筑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) 成都市将军碑建筑模板有限公司研发楼最后100d的平均沉降速率为0.003mm/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) 建筑物未发现裂缝等异常。

5) 成都市将军碑建筑模板有限公司研发楼平均沉降速率为0.003mm/d,达到《建筑变形测量规程》JGJ/8-2007规范规定:“沉降速率小于0.01-0.04mm/d,可认为已进入稳定阶段。”

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distributed points as a cluster, and then extract the target point clouds.
Key words Density-based clustering algorithms, the density distribution of point cloud, noise remove (Page:101)

Method of Basic Geographical Information Module Implementation Based on Google Earth by YIN Qiang

Abstract This paper introduced the mentality and the implementation method of kinds application subsystem general modul redevelopment based on Google Earth platform. It elaborated the implementation method of control and browse module and geographical information module, and implemented format conversion of the shp to kml file in the system.

Key words GE , basic geographical information modul , kml , format conversion (Page:105)

Establishment of the Geographical Name Inquiring System of Fuxin City Based on MO by REN Dongfeng

Abstract This paper talked about establishing the geographical name inquiring system of Fuxin city based on MapObjects controlling and VB language and in the foundation of the geographical name geodatabase of Fuxin city. The system achieved the function of brose, layers management, drawing, the geographical name inquiring, the buffer analysis, the shortest path analysis.

Key words geographical name inquiring system; system design;buffer analysis; path analysis (Page:107)

Formulas of Calculation of Road Horizontal Curve Coordinates in the Route Plane Control Survey Coordinate System by ZHEN Dengchun

Abstract A method of direct calculation of road horizontal curve coordinates in the route plane control survey coordinate system is introduced, and the related formulas, compact and practical, can be referenced for setting out of road horizontal curve, are derived.

Key words road;horizontal curve;coordinate calculation (Page:111)

Calculation and Application of Various Area in the Second Land Investigation by ZHANG Hui

Abstract This paper analyzed working method and mathematical models of line and sporadic feature, summary the advantages and disadvantages of various area proposed the improving and using direction, by Comparison between calculation formula of ellipsoid area and working method and precision assessment in the first land using status investigation.

Key words land investigation; area mature; precision assessment (Page:115)

Investigation about the Subdivision of the Digital Estate Figure of Wuhan by CHEN Zhen

Abstract The subdivision of the estate figure is apart of the plan of the real estate framing, and it's the basic figure of drawing and issuing the figure of the license of the estate. According to the provision of the property management at Wuhan, there are two ways of surveying and mapping the subdivision the figure. Framing is the basic unit of surveying and checking of the estate which is a very important code at surveying and management, and it is also the major index at the management of the records. The standardization of surveying and mapping the subdivision the estate figure is benefit for the department of the estate management, which can also support the service of the department. This thesis showed us some research about the surveying of boundary points, the coordination of the corner of the buildings, the serial number of the buildings and so on.

Key words the subdivision of the estate figure, express content, in-

vestigate of the technique (Page:118)

Role of Detection of Underground Pipeline in Municipal Engineering Design by XIAO Shun

Abstract Underground pipeline survey before carrying out municipal engineering is very important. This issue illustrated this significance by explaining the important role detailed municipal pipeline survey plays in municipal engineering, comparing between detailed municipal pipeline survey and underground pipeline survey and their pre- and follow-up services. Several illustrative cases were provided to enhance the conclusion.

Key words municipal engineering design, detailed municipal pipeline survey ,detection of underground pipeline (Page:121)

Design and Analysis of the Deformation Monitoring Program about a Foundation Ditch in Chengdu by LI Yong

Abstract This paper summarized the foundation excavation monitor need pay attention to in the basic problems and general principles and combining QingyangQu red east street in a Chengdu deformation observation projects analyzed the project operation processes involved with some typical problems including project profiles , benchmark layout ,observation period and so on contents and combined with actual situation corresponding conclusion.

Key words foundation ditch ,benchmark ,observation period (Page:125)

Optimum Design of CP Plane Control Network for High Speed Railway by XIAO Daiwen

Abstract By doing the simulation optimum design, the positional accuracy ,relative positional accuracy and reliability of CP networks was analysed, and the result showed the reliability of CP network was bader. The optimum scheme of CP network was presented. And frequency of repeatable measurement of this CP network may was reduced.

Key words CP plane control network ,positional accuracy ,reliability ,optimum design ,ballastless track (Page:127)

Thoughts of Surveying and Mapping Engineering Supervision by PENG Songlin

Abstract This paper starts with the analyzing the origin of relation and distinction of engineering supervision and project supervision, to discuss the need for the implementation of mapping and project supervision, and how could it be practiced. The focus is on how important the organization, legal system, market construction and other work are in promoting mapping and project supervision.

Key words supervision ; engineering supervision of surveying and mapping ,organization construction ,legal system construction ,market construction (Page:130)

Design and Practice of Deformation Monitoring of Building by FU Hai'ou

Abstract This paper expounded the design of the building's settlement monitoring process to Chengdu general tablet research building structural template Co., LTD as an example, the level of the stability analysis, combining results point on the watch for observation data statistics and analysis, and a detailed corresponding conclusion.

Key words subsidence monitoring ,baseline point , stability (Page:133)

Application of Regession Analysis Model in Dam Deformation Monitor by YANG Yongchao

Abstract This article focused on a regression analysis to monitor dam