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The Façade Lighting of Ping An Finance Center

超高层建筑外立面光的筑造——平安国际金融中心

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Abstract | 摘要

Our Company, as the general contractor of the façade lighting engineering for this project, created a series of optimization designs in the process of implementation specifically according to the project requirements. We integrated products with different brands and different types into a set of advanced control systems for unified control and management, and adopted the integrated installation with the curtain wall structure for 80% of the lighting products in this project, greatly reducing the aloft workload and the resulting risks on such a super high-rise building site. Additionally, the monitoring and feedback functions over the operation and fault states of lighting devices were added because of the particular lighting demands of such a building, so that accurate positioning and quick maintenance are possible if any damage to the lamps and lanterns occurs.

Keywords: Construction, Façade, Light, Optimization, and Technology

平安国际金融中心是深圳的地标建筑，位于CBD核心区，建筑高度592.5m。作为该项目夜景照明工程总承包方，在实施过程中我方针对项目需求及具体实施做出了一系列的优化设计。在该项目中我们将各个不同品牌以及不同类型的产品集成到一套控制系统中进行统一的控制和管理，并且该项目80%照明产品均采用与幕墙结构一体化安装的方式，大大减少了超高层建筑现场高空作业的工作量以及其所带来的危险性。另因超高层建筑对照明需求的特殊性，在该项目中加入了对灯具运行、故障状态的监控及其反馈功能，以便对损坏灯具进行准确定位，并快速维修。

关键词：施工、幕墙、照明、最优化、技术

Project introduction

Ping An Finance Center, a landmark building in Shenzhen, is located in the central business area of Futian District. The building will be 599m tall, consisting of a 118-story tower with a nine-story podium, and will become the tallest building in Shenzhen after completion. Since 2009 when the construction began, it has been continuously breaking records in engineering construction and creating many world firsts. Ping An Finance Centre is expected to be completed in 2016. Floors 115 and 116 will serve as the observation decks, where visitors can enjoy a bird's eye view of Shenzhen.

Design Philosophies and Elements

Considering the tower's important role as a Shenzhen landmark and future commercial uses of the project, Chinese elements were widely used in the design of the project. For example, the spire adopts the chamfered diamond folding; the observation deck adopts the accordion folding, like an opened folding fan showing grandiosity; and the podium façades integrate multiple different forms, including the internal and external intersection,

项目介绍

平安国际金融中心作为深圳地标性建筑，地处福田商业核心区域。建筑完成高度为592.5m，由118层塔楼及9层裙楼组成，建成后将成为深圳第一高楼。自2009年开工以来，不断刷新各项工程建设记录，创造了多项世界第一！平安国际金融中心项目预计在今年全部完工，115层以及116层将作为观光塔，届时深圳市民可在此远眺观景，体验一览众山小之感。

设计理念及元素

在该项目中，考虑到其作为深圳市地标性建筑的重要作用及未来的商业用途，在设计中广泛应用了中国元素。如建筑塔尖采用斜切式钻石折叠；观光平台采用手风琴式折叠，犹如一把打开的折扇，美轮美奂；裙房立面运用内外交错凹凸及变角度有序的叠加，在韵律中做倾斜的渐变，为深圳平安国际金融中心增添了更多的艺术美感。

此外，建筑外立面照明基于建筑结构"折纸"元素，将其塑造成如钻石般闪亮的地标图腾，并引领深圳经济的发展。塔楼上部照明犹如城市月光，架起冰冷都市与

concave-convex, and orderly overlaying of variable angles, all constructed as a slope gradient in rhythm, which adds additonal artistic aesthetic feeling.

In addition, based on the "origami" elements of the building structure, the building façade lighting was designed to be a diamond-shaped, shining landmark totem, indicating the lead of the development of Shenzhen economy. The lighting on top of the tower looks like the moonlight above the city, building connections between the "cold" city and nature. The media curtain walls on the main façade function as the communication media between people and city, showing colorful architectural expressions. The lighting of the oblique folding area looks like the shining edges of a diamond. The lighting of the mechanical floor in the middle of the tower connects the upper and lower parts of the building, and the podium lighting shows like sunshine scattering in the concave and convex, forming a fascinating and gorgeous scene (Figure 1).

Difficulties in Lighting Construction, and How to Address

The lighting of supertall building projects has more challenges during the construction process, compared to regular buildings. Firstly, there is a wide range of lamps used on the building from the first floor to the tower crown – including 9 different brands and 12 types of lamps (7 types of dimming lamps and 5 types of switch lamps) – almost 130,000 control points, and 8,000 monitoring points (Figure 2). It involves many different specialties, so the corresponding adjustments for lighting work are required when the building design is changed during the construction process, which greatly increases the difficulties of construction. Therefore, during the implementation process of the lighting project, the predictable challenges need to be identified and solved in the early design period; the unexpected difficulties and requirements need a more rapid response and appropriate solutions.

Multiple Brands and Types of Lighting Equipments are Integrated into a Large Intelligent Control System

The large-scale intelligent lighting control system involves multiple brands and types of lighting equipments, and its technology is complex in implementation. The framework of the control system consists of the control system and a monitoring-feedback system, which not only contains the ON/OFF control of lighting power system, lighting effect

Figure 1. Building night view showing lighting effect (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图1. 建筑夜景效果展示（来源：北京富润成照明系统工程有限公司）

大自然的联系，主立面媒体幕墙作为人与城市沟通的媒介，呈现丰富多彩的建筑表情，斜切折叠区域的照明犹如钻石闪亮的棱角；塔楼中部设备层照明承上启下；裙楼照明犹如阳光洒在凹凸交错间，形成迷人眼的绚烂（图1）。

照明实施的难点与解决方式

超高层建筑照明工程相比一般建筑照明工程存在更多施工难点，首先灯具的种类繁多：从建筑首层至塔冠部分使用了9个品牌的照明产品，共计12种类型照明灯具，其中调光类产品7种、开关类产品5种，灯具的控制点数接近130000个，监控点数接近8000个（图2）。加之涉及相关专业繁多，施工过程中不乏各种设计变更及调整，由此照明专业也需随之调整，施工难度大大增加。因此在照明实施过程中，可预见的难点需前期预先解决；突发的困难及需求更需迅速反应，并提出解决方案。

多品牌、多种类照明设备整合于一个大型智能控制系统

大型智能照明控制系统涉及面广，涵盖了多品牌、多种类的照明设备，技术实现复杂，控制系统框架由控制及监控反馈两部分组成。不仅包含了建筑立面照明供电系统的开闭控制、照明的效果控制、航空障碍灯的控制，还包含了建筑立面照明、航空障碍照明及节日照明的工作、故障状态的监控与反馈（图3）。

整套系统采用通讯协议为TCP/IP的以太网结构传输控制信号，并采用星型拓扑结构通过级联的方式将网络扩展，该种方式也是目前以太网广泛采用的结构及级联的方式。照明的分控设备输出信号均采用标准的DMX512的通讯协议，如此满足了可以将第三方DMX512调光类型的照明产品完全纳入到该控制系统中；开关类型的照明

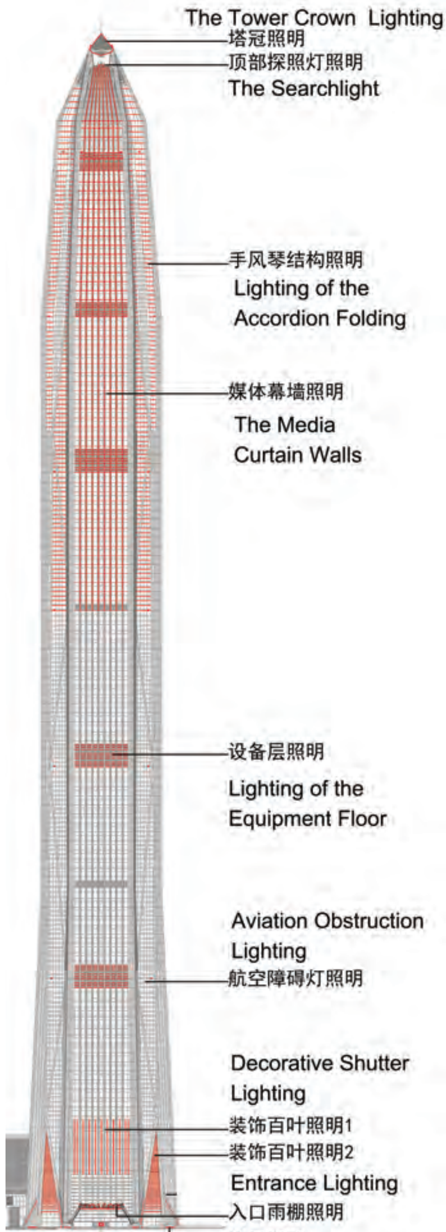

Figure 2. Façade lighting layout (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图2. 建筑立面灯具布置（来源：北京富润成照明系统工程有限公司）

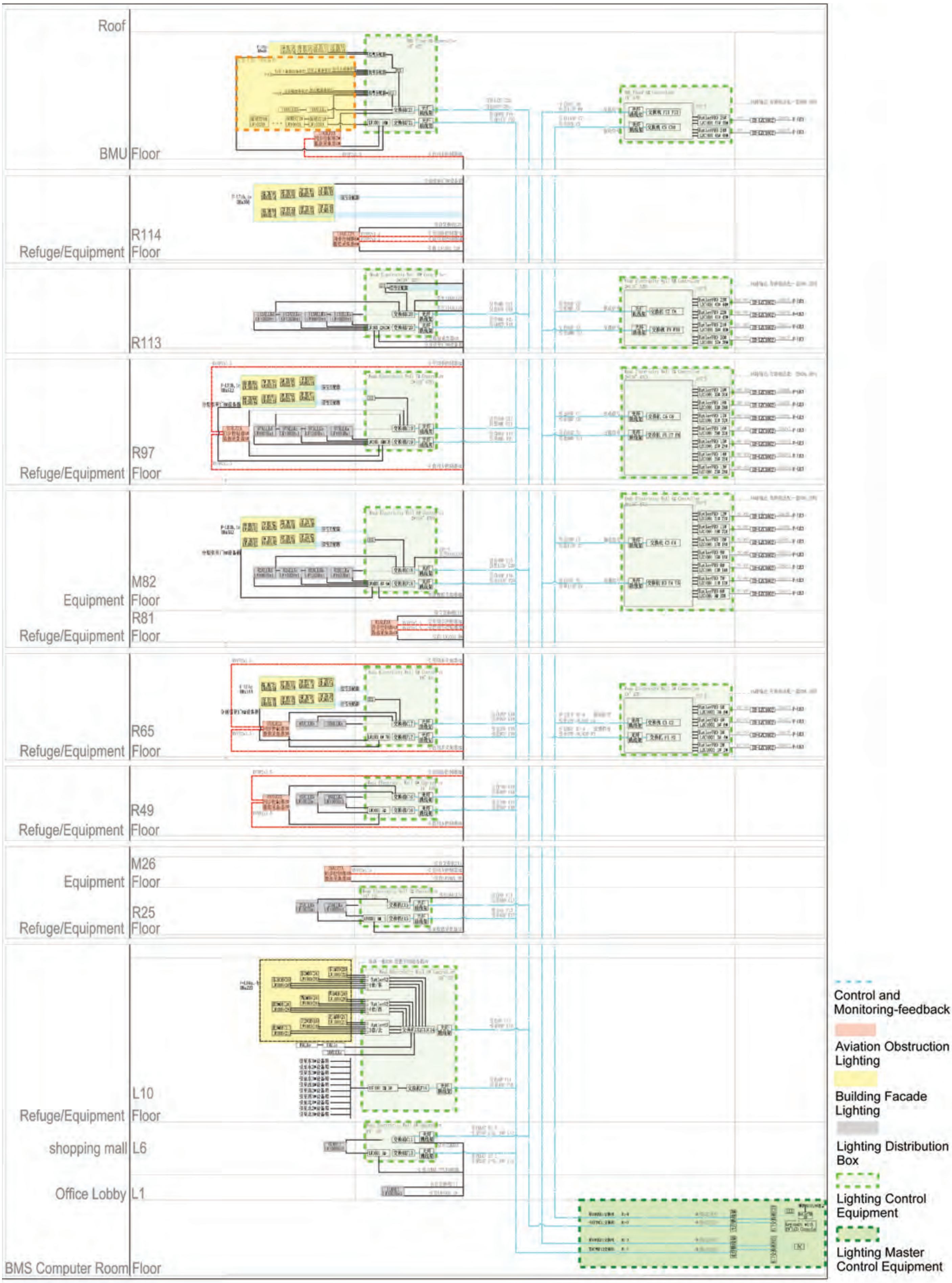

Figure 3. The framework of the lighting control system（Source: Beijing Fortune Lighting System Engineering Co., Ltd. ）
图3. 照明控制系统框架图（来源：北京富润成照明系统工程有限公司）

control, and aviation obstruction light control of building façades, but also contains the building façade lighting, aviation obstruction lighting, special lighting on holidays, and the monitoring and feedback reception mechanisms of fault conditions (Figure 3).

The entire system adopted an ethernet fabric with a communication protocol of TCP / IP to transmit control signals, and a star topology to expand network through cascade connection, which is a structure and cascade mode currently widely used in ethernet fabric. The output signals of all the distributional control system used a communication protocol of standard DMX512, which enabled the third-party, DMX512, dimmer type of lighting products to be fully involved into the control system; the switch type of lighting products use I / O control devices installed in the lighting distribution box to control the on-off switch circuit, thereby achieving a unified control of overall lighting. In this project, with the help of a lighting control system, the luminous intensity of lamps used on the building façades can be integrally adjusted in the later debugging period of lighting effect, which allowed a mutual coordination in the luminous effect of various lamps and a mutual coordination between the façade lighting and the surrounding brightness. In this way, not all the lamps had to be turned on at the same time, so it would also achieve energy-saving purposes.

The volume of lighting equipments for high-rise façades is typically huge, and when a fault within a single lamp or lighting circuit occurs, it is difficult to locate accurately using the naked eyes. This issue brings a great deal of inconvenience for the workers in the later maintenance stages. Therefore, this project realized monitoring and receiving feedback functions regarding the operation or fault conditions of overall façade lighting, by which the monitoring personnel would be easily able to observe the feedback information from any fault occurred at any points/locations of the building, then to quickly and accurately locate these fault points, and to fix them, in order to greatly reduce the risk of high-altitude operations. This approach is unique to be applied in supertall building projects nationally and internaionally.

1. The methods of monitoring and receiving feedback:

Lamps and controllers with lighting adjustment of RDM function

Under the RDM protocol, the lighting settings can be changed through control pannels. Each lamp compatible with RDM can be identified through the unique built-in identification code. If a certain lamp or controller containing RDM has faults, they can be accurately located, and there would be no need for the maintenance personnel to exclude the fault points one by one within a specific area. This technology has been applied in some other lighting projects of large-scale stages, but barely applied in the floodlighting of building façades .

The products without the RDM function can be monitored by increasing the number of current sensors

This project used various types of lamps, so not every lamp has an RDM function. Then the questions becomes how to achieve monitoring and feedback of lamps under its working status for those without RDM function? A seemingly ordinary but very practical method was used, which was that the current sensors were used to monitor whether the current data of each power supply circuit was normal. This kind of method was also unique in the lighting projects of outdoor architectural façades.

2. The integration of photoelectric isolator equipment achieved a comprehensive lightning protection. Usually, the main lightning protection measures of the façade lighting are the surge protection devices in the power distribution box. For high-rise projects, the lightning protection measures are particularly important. So, in addition to setting the surge protection devices in the high voltage system, the photoelectric isolation devices were also added in each control loop of the low voltage system, supplying a double protection for the low voltage system in order to improve the operational reliability of façade lamps.

It is Important to Conduct a Reasonable Arrangement in Construction Processes and Periods of Lighting Work on High-Rise Buildings

Considering the construction safety and overall schedule, the lamps of the media curtain wall at the top of tower were pre-installed on the modular planels in the curtain wall plant and then installed on-site together withthe curtain wall modular planels according to overall construction progress. In this way, the workloads of high-altitude operations on-site would be reduced greatly, and its danger coefficient would be decreased accordingly. However, there still existed great difficulties in the lighting implementation and maintenance stages due to the design adjustments of various specialties and changes required by the owner.

产品，则采用安装于照明配电箱中的I/O控制设备去控制各开关回路的通断，由此以实现整体照明的统一控制。本项目利用照明整体控制系统，在后期照明效果调试中将大厦外立面的所用灯具的发光强度进行统一的调整，不但使各种类灯具的发光效果相互协调，还使得本建筑立面照明与周边环境亮度相互调节。这样做可以肯定不是所有灯具都是完全开启的，从而达到节能效果。

超高层建筑立面照明设备体量庞大，某一灯具或回路出现故障，仅凭肉眼很难准确定位故障点，为后期检修工作带来极大的不便，因此在本项目中运用了对整体立面照明设备的工作、故障状态的监控及反馈功能，监控人员可以在监控屏幕上轻而易举的观察到建筑所有位置的任何故障点的反馈信息，从而快速、准确的定位并进行故障维护，极大地降低了高空作业的危险性。这种做法在超高层建筑项目中，不仅国内乃至世界范围内也是独一无二的。

1.监控及反馈实现方式：

- 调光控制的灯具或控制器自带RDM功能

在RDM协议下，可以通过控制台更改灯具设置。每台兼容RDM的灯具都可以通过其内置惟一识别码来进行识别，如果某个含有RDM的灯具或控制器出现故障，便可以准确定位其位置，而无需检修人员去故障区域逐个排除故障点。该技术虽然在一些大型的舞台灯光有应用先例，但应用到建筑立面泛光照明却还是寥寥无几的。

- 未带RDM功能的产品增加电流感应器进行监控

本项目使用灯具种类众多，并不是每款灯具都带有RDM功能，如何实现灯具工作状态的监控及反馈？在深化过程中采取了看似普通但又实用的方式——即电流感应的方式去监控每个供电回路的电流数值是否正常。该种方式在室外建筑立面照明项目中也是独一无二的。

2.增加光电隔离器设备，达到全面防雷。通常建筑立面照明的防雷措施只是在配电箱中设置浪涌保护器，而超高层建筑项目，后期的防雷措施尤为重要。因此除了在强电系统中配置浪涌保护器，在弱电系统每个控制回路中都增设光电隔离设备，为弱电系统增添了双重的防护措施，提高了建筑立面灯具运行的可靠性。

合理化安排超高层建筑照明施工步骤及工期。为施工安全及整体施工进度考虑，塔身上部媒体幕墙部分灯具预计均在幕墙加工厂的单元板块上预先安装，并根据幕墙施工整体进度与幕墙单元板块一同现场安装。如此，大幅度减少了现场高空作业的

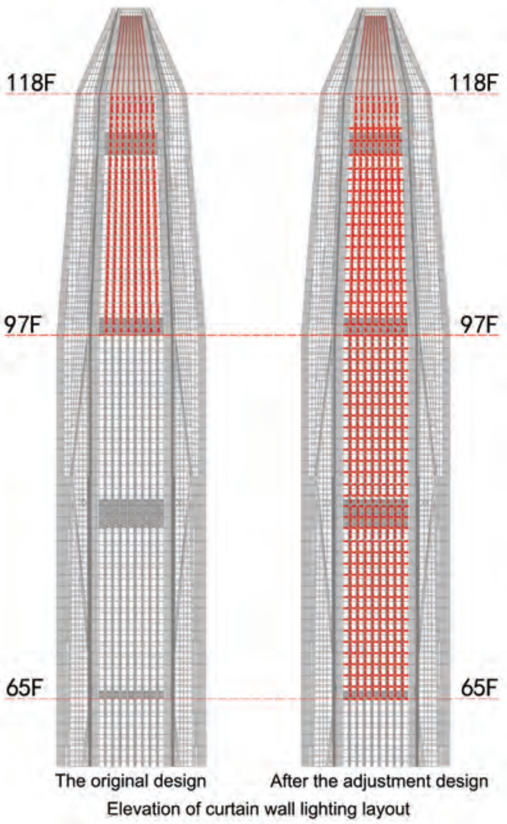

Figure 4. Elevation of curtain wall lighting layout (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图4. 媒体幕墙灯具布置（来源：北京富润成照明系统工程有限公司）

Combination of Night Display and Brand Promotion

In the lighting construction, the owner expected various expressions shown on the building at night in order to further achieve the purpose of brand promotion. As a result, it brought more challenges in lighting work, including lamp arrangements and control, as well as the installation afterwards. After conducting multiple analyses and demonstrations in the detailed lighting design stage, the decision was finally made to change the 32-column lighting devices with vertical triangular decorative wings on the four façades from the 97^{th} to 118^{th} floors to the 65^{th} to 118^{th} floors. and also add two lines of lighting devices with lateral triangular decorative wings for each floor (Figure 4). In the meantime, the lighting control points were increased from the originally planned 40,000 points to 120,000 points, which also changed the display effect from a style with simple abstract graphics and gradient color to a media curtain-wall style with more delicate and abundant images. However, it brought the added challenge of a relatively intense construction schedule, caused by the increasing number of lamps, in which it was unable to catch up with the construction process of curtain wall units on 65^{th}–80^{th} floors. The construction schedule, which was originally long enough, became a problem. In order to meet the owner's requirements without delaying the construction process, a two-step method was taken in this part of lighting work: the products above floor 80 were synchronously assembled in the curtain wall plant as planned; the products below floor 80 were installed on-site by using window-cleaning machines once the site condition was ready for installation.

The media curtain walls of the building façade, as a highlight of the whole building lighting, is also a technical difficulty. The lamps were mainly arranged on 65^{th}F–118^{th}F. Specifically, the point LED lamps with single point power of 3.5W RGB were arranged in the internal triangle decorative wings of horizontal and vertical curtain walls (Figures 5 and 6) on the four building façades, which were tested by several rounds of sample experiments in the early design period. The detailed analysis and demonstrations were carried out regarding the types of lamps, the structure of curtain wall units, the coverage rate of light holes and the internal installation structure of triangle wings. In the initial design stage, the LED lamps of the vertical curtain wall's decorative wings, forming a vertical line, were installed in the center position of internal space (Figure 7), and the light spreaded out through the light holes on both ends, achieving an ideal effect in the first few sample tests with close-distance observation. But in the later building sample tests with equivalent height conditions on-site, it was found that the penetrating light intensity of light holes on both ends was relatively weak when standing in the face direction of triangle wings to observe at a long distance. Ultimately, the lamps were installed in an S shape after this test, and the lamp arrangement was changed from the original vertical-and-line installation to left-right installation, so as to ensure a whole lighting effect of media curtain walls to be seen from every viewpoint (Figure 8).

It is also worthy to briefly introduce the methods of optimizing the high-altitude installation and maintenance of the media curtain walls. LED string lights were installed point by point on the internal supporting structure of the curtain walls, by which a huge workload made it difficult to ensure the consistency of lamp arrangements, and also brought complicated maintenance work in the later period. Therefore, in the installation of lamp points, the string lights were pre-fixed on the aluminum backboard units according to the uniform spacing, and the aluminum backboards were fixed as a whole on the internal structure of the curtain walls. Thus, this approach was able to ensure the consistency of vertical lamp spacing in which the aluminum backboard and the LED string lights fixed on it were allowed to be taken off together.

工作量，降低了高空作业的危险系数。然而各专业的设计调整对照明的实施，后期的维护都造成很大的困难。尤其业主方需求的变化，对照明实施存在巨大的影响。

夜景展示及品牌宣传的融合

在照明施工中，业主方提出期望赋予建筑更丰富的夜间表情，从而进一步达到品牌宣传的目的。如此一来，从灯具布置到控制要求，甚至后期安装等诸多相关工作安排都带来了巨大的挑战。经过照明深化设计的多方分析及论证，最终确定将四个建筑立面共32列竖向三角装饰翼照明，由97F～118F调整为65F～118F，并每层增加2行横向三角装饰翼照明（图4），照明控制点由原设计的4万个点调整为12万个点，展示效果由简单抽象图形及光色渐变转变为成像效果更为细腻、图像更加丰富的媒体幕墙形式。但随之而来的挑战是：灯具数量的增加造成了施工周期的相对紧张，无法赶上幕墙65～80层单元板块的加工进度。原本充裕的施工周期，此时成了一个难题。为了实现业主的需求又不耽误整体工期，此部分照明施工采用两步走的方式：80F以上产品按计划在幕墙加工厂内同步组装完成，80F以下产品待现场具备安装条件后，采用擦窗机进行现场安装。

建筑立面媒体幕墙做为整个建筑照明的亮点，也是技术难点。灯具主要布置于65F~118F。运用单点功率3.5W RGB LED点串灯具布置在建筑四个立面横向、竖向幕墙三角装饰翼内部（图5、6），该部位在设计初期经历了多轮样板实验，针对灯具类型、幕墙单元板块的结构、透光孔的覆盖率以及三角翼内部安装结构等做了详细的论证。在初始设计过程中，竖向幕墙装饰翼中的LED灯具成一条竖向直线安装在内部空间的正中位置的（图7），灯光通过两端的透光孔发散出去，在前几次近距离视点观看样板测试时效果尚且较为理想，但在后期现场具备同等高度条件的楼体样板测试中，却发现远视点观看灯光效果时，站在三角翼正视方向，两侧透光孔透光强度相对较弱。经过此次样板测试最终确定将灯具进行S型安装，即将灯具布置由原来的一条竖向直线安装调整为一左一右安装，如此确保每个视点都可以观看到媒体幕墙完整的照明效果（图8）。

优化媒体幕墙高空安装及维修的方式。LED灯串逐点安装在幕墙内部支撑结构上，工作量巨大，很难保证灯具排布的一致性，且后期维修工作非常复杂。因此深化灯具安装节点时，预先将灯串根据统一点间距固定在单元铝制背板上，并将铝背板作为一个整体固定在幕墙内部结构上，如此既保证了竖向灯点间距的一致性，后期维修也非常简易，只需将单元铝制背板及固定在上面的LED灯串整体取下维修。

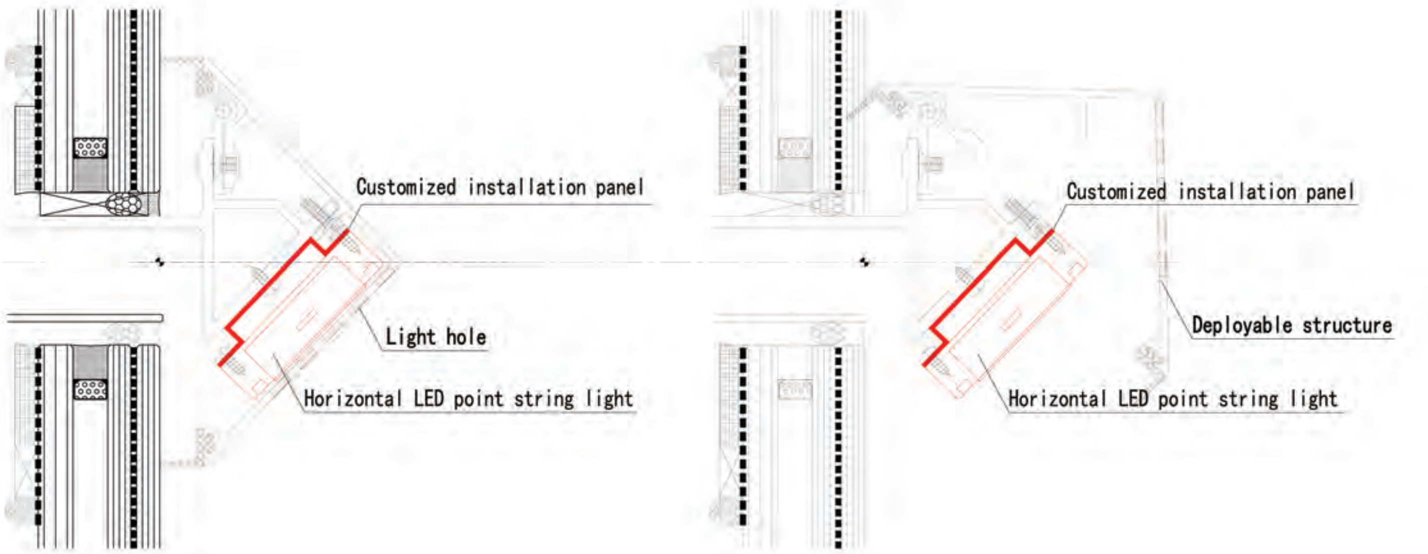

Figure 5. Installation node diagram of a lighting fixture for the horizontal decorative wing of the media curtain wall (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图5. 媒体幕墙装饰翼灯具安装节点剖面图（来源：北京富润成照明系统工程有限公司）

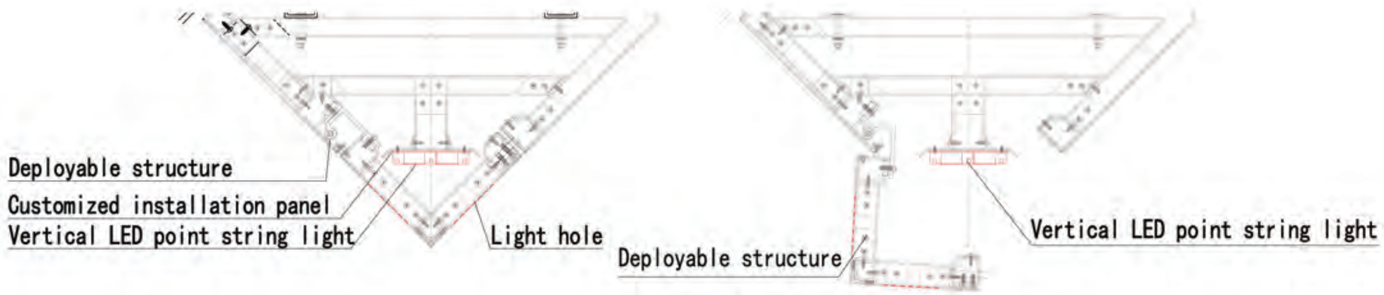

Figure 6. Installation node diagram of a lighting fixture for the vertical decorative wing of the media curtain wall (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图6. 媒体幕墙装饰翼灯具安装节点平面图（来源：北京富润成照明系统工程有限公司）

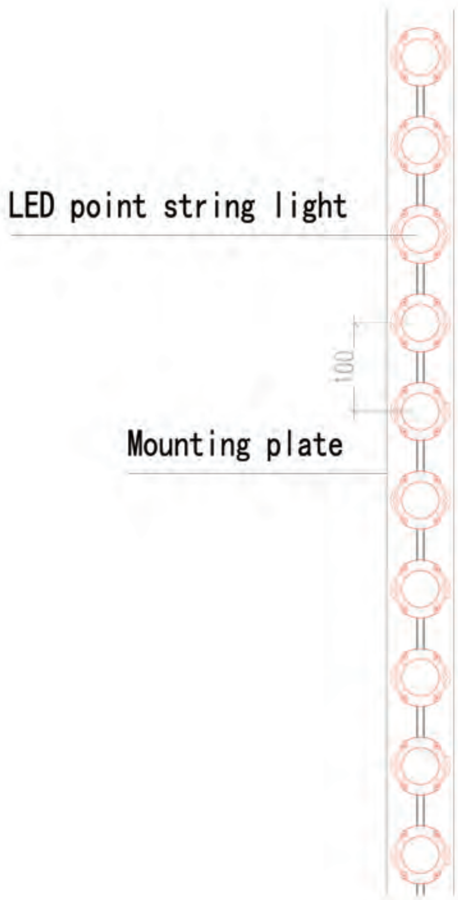

Figure 7. Layout of the original design of the lighting fixture for the vertical decorative wing of the media curtain wall (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图7. 媒体幕墙装饰翼原设计LED点串灯灯具布置（来源：北京富润成照明系统工程有限公司）

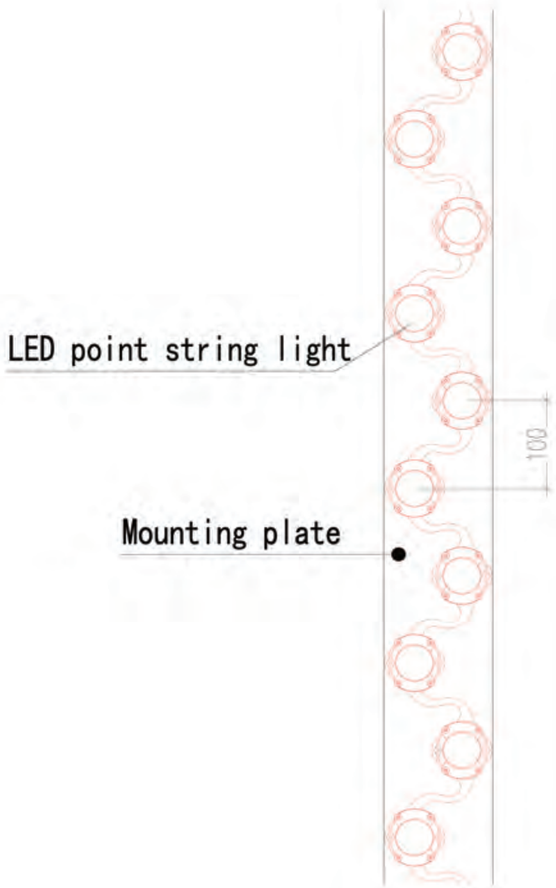

Figure 8. Layout of the lighting fixture for the vertical decorative wing of the media curtain wall after the adjustment (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图8. 媒体幕墙装饰翼深化设计LED点串灯灯具布置（来源：北京富润成照明系统工程有限公司）

In the original design proposal, the power supply and control equipments of lamps with a height ranging from 305.7m to 575.5m located betweem 65th F–118th F were going to be installed within the office area of the floors where the lamps were installed, but that would have required tens of thousands of outlets to be reserved on the curtain wall structure. In this case, this design would cause great inconvenience for future maintenance. Therefore, in the detailed design, the power supply and control equipments were set on mechanical floors – 65, 82, 97 and 113 – achieving a maximum decrease in the number of outlets reserved for outgoing lines of lamps.

However, it brought new problems. On the one hand, the specification of extension lines from controllers to some curtain-wall lamps configured by the original manufacturers did not meet the requirements of the system pressure drop. In order to achieve a centralized arrangement of equipments, the extension lines were determined to be customized according to the actual requirements of the project after several rounds of tests with manufacturers. On the other hand, there are many differences in the length of control lines, because the control lines for each set of lamps, with a total amount of 6,000 lines, are independent, and all required to extend to the equipment floors. The distance from lamps to control boxes on equipment floors also varies greatly. Therefore, a lot of statistical work was conducted in order to avoid unnecessary waste at the greatest extent. Moreover, the places where control lines enter into equipment floors requires careful arrangements and calculations. For example, the LED flexible rope lights were installed at the accordion fold position, where there was bevelled post-and-beam construction, and the lateral decoration wings of the curtain wall were not continuous, so the lamp control lines were unable to be arranged continuously. However, this issue was solved after multiple discussions with the curtain-wall professionals and many test demonstrations in the curtain wall plant (Figures 9 and 10). It clearly demonstrates that the overall routing and installation of lighting projects is complicated.

There are always inconsiderate points in the design schemes, so the detailed design should be able to help with checking and revision. The design adjustments in various specialty teams brought great difficulties in the lighting implementation and maintenance. For example, two problems were found in the searchlight used for holiday lighting on the tower crown after initial detailed design and preparation: on the one hand, in the original design, the lamp with a weight of 220kg was installed on the top of a 2mm stainless-steel plate of curtain walls, where there was no load-bearing construction; on the other hand, the lamps were installed at the top of the window-cleaning machine floors, where the manholes did not meet the size requirements of lifting lamps. After finding these problems, the lighting-implementation party timely coordinated with the owner, the designer and many other parties to communicate, discuss and propose final solutions: the structural

安装在65～118F，高度由305.7m至575.5m的灯具控制设备，在原始设计中此部分灯具的供电及控制设备均安装在灯具所在层的办公区内，如此，势必需要在建筑幕墙结构上预留几万个出线孔，为日后维护检修带来了极大的不便。因此在深化设计时将供电、控制设备集中设置在65F、82F、97F、113F设备层，这样最大程度的缩减了因灯具出线所需预留的出线孔数量。

可随之而来了新的问题：一方面媒体幕墙部分灯具原有厂家标准配置的控制器至灯具的延长线规格无法满足系统压降。为了实现设备集中布置，经过与厂家反复多轮测试，最终根据项目实际需求定制不同规格的延长线。一方面因灯具控制线均需引到设备层，每套灯具控制线均为独立的，总数量多达约6000条，每套灯具距离设备层控制箱的距离也千差万别，造成控制线长度规格各不相同。为此深化过程中进行了大量的统计工作，最大程度避免不必要的浪费。另一方面控制线从哪些位置进入设备层，需要细致的排布及统计。例如建筑手风琴式折叠位置的LED柔性灯带，折叠位置均为斜切的梁柱结构，且该部位幕墙横向装饰翼并不连续，灯具控制线无法连续布置，经过与幕墙专业的多番沟通，并在幕墙加工厂进行试验论证才得以解决（图9、10）。由此节点可看出整体照明走线安装的复杂程度之大。

设计方案中总有考虑不周之处，深化设计需查漏补缺。各专业设计方案的调整对照明的实施，后期的维护造成了很大

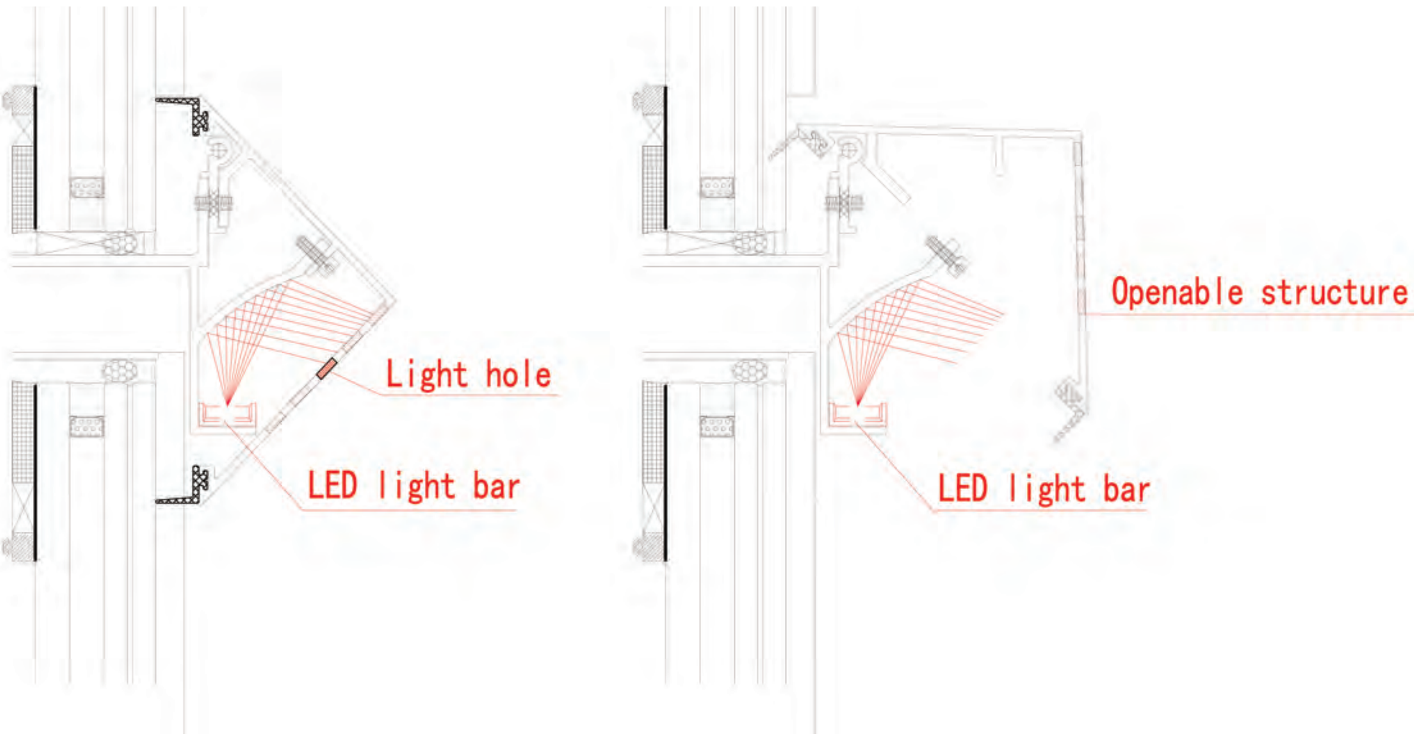

Figure 9. Installation mode diagram of lateral decorative wing lights on the curtain wall at the building corner (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图9. 建筑转角区域装饰翼横向灯具安装节点图（来源：北京富润成照明系统工程有限公司）

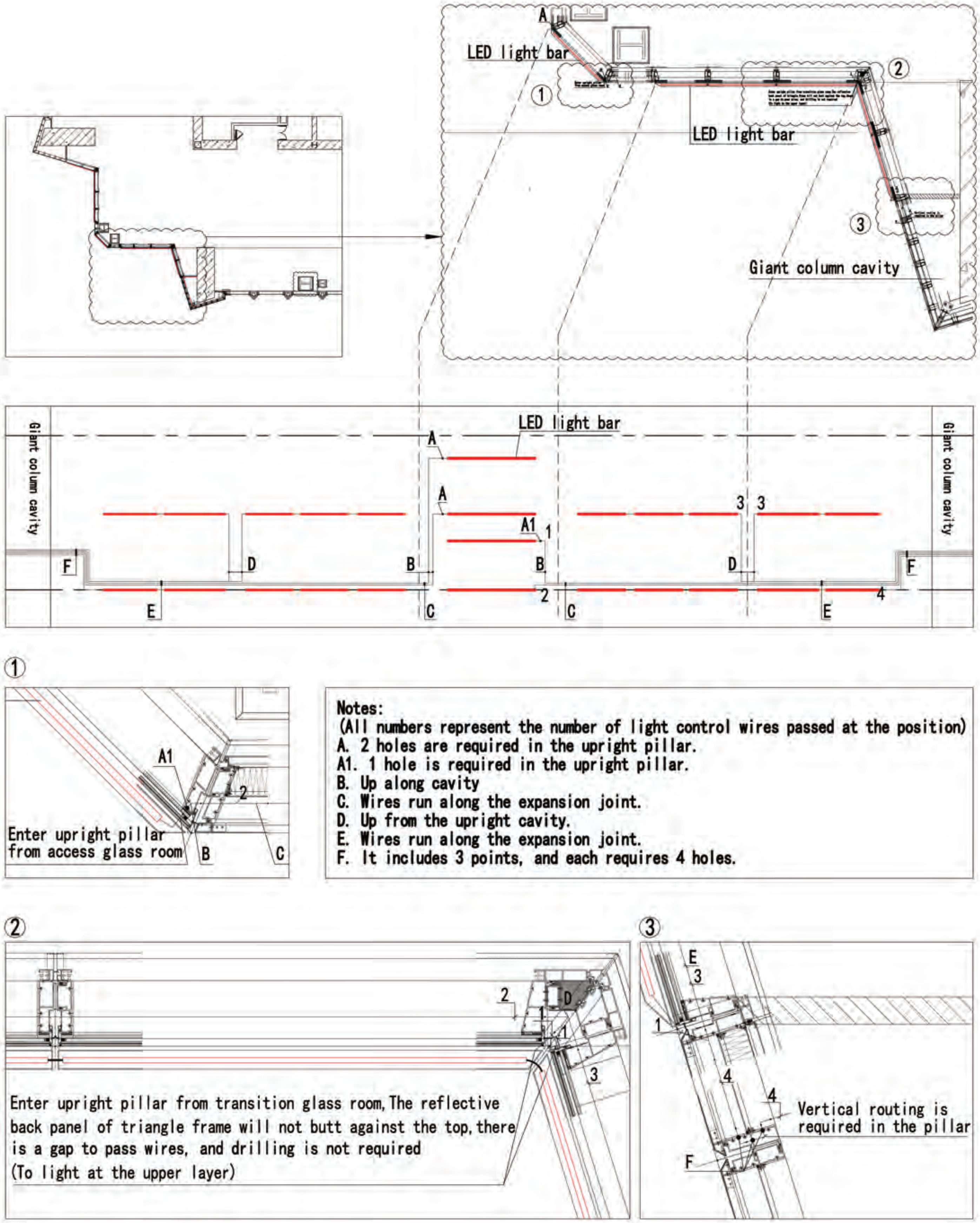

Figure 10. Line holes for LED lights and quantity of control wires at building corner (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图10：建筑转角区域LED灯具穿管布线控制原理图（来源：北京富润成照明系统工程有限公司）

specialists carried out the welding work of a supporting structure at the bottom of lamps; and the curtain wall specialists reserved lifting holes to ensure a smooth installation of lamps (Figures 11 and 12).

的难度。例如建筑塔冠用于节日照明的探照灯，经过前期深化设计筹备，发现两个问题：一方面原设计中重达220kg的灯具安装在幕墙2mm不锈钢板顶部，而该位置没有任何承重结构；另一方面由于灯具安装位置位于擦窗机层的顶部，该位置的检修孔无法满足灯具吊装到位的尺寸需求。发现该问题后，照明实施方组织业主、建筑设计等多方及时进行问题的沟通及讨论，形成最终解决方案：由结构专业进行灯具底部支撑结构的焊接工作；幕墙专业在深化设计过程中预

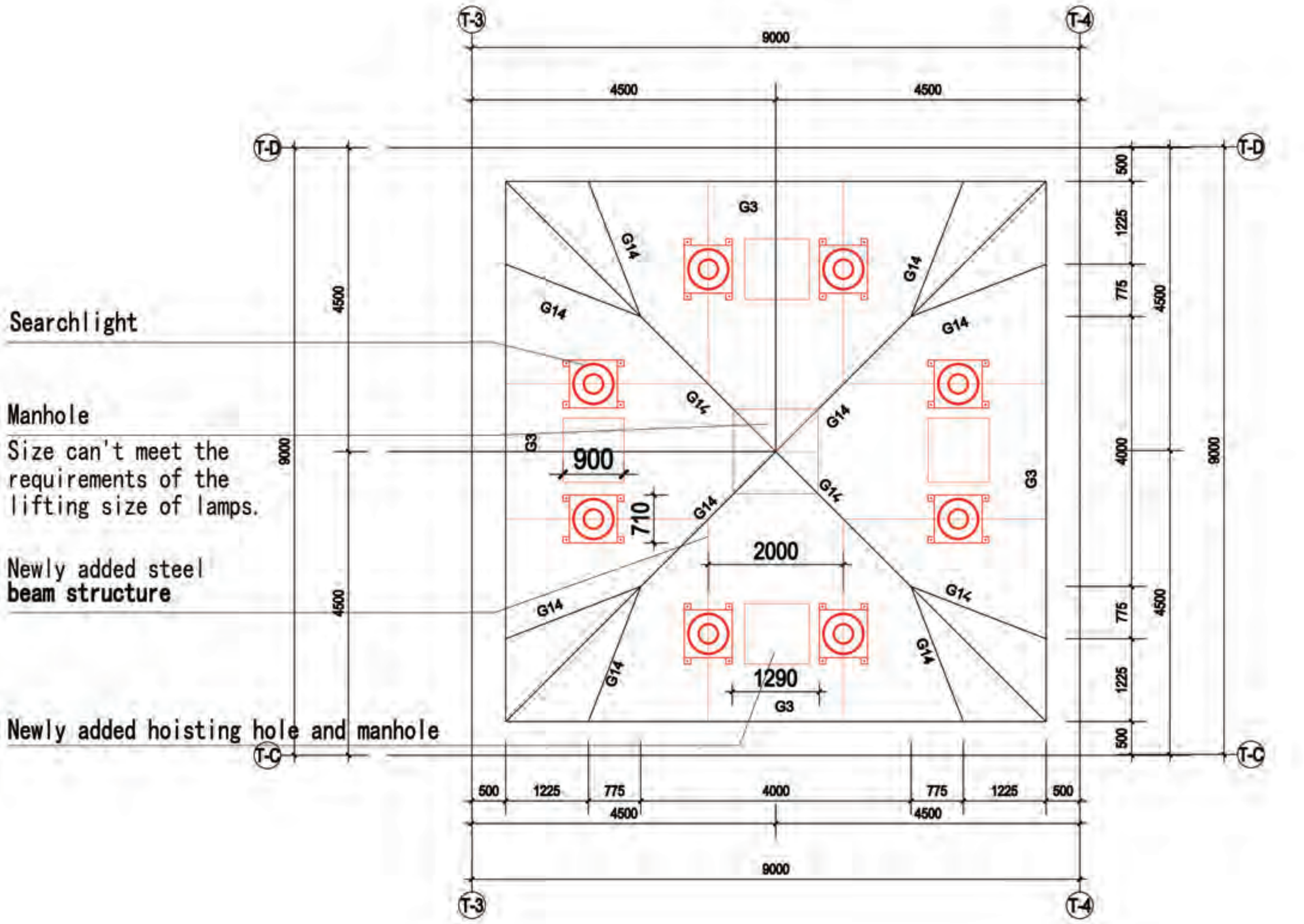

Figure 11. Structure adjustment diagram of the installation position at the top of the tower (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图11. 塔冠灯具安装位置结构调整平面布置图（来源：北京富润成照明系统工程有限公司）

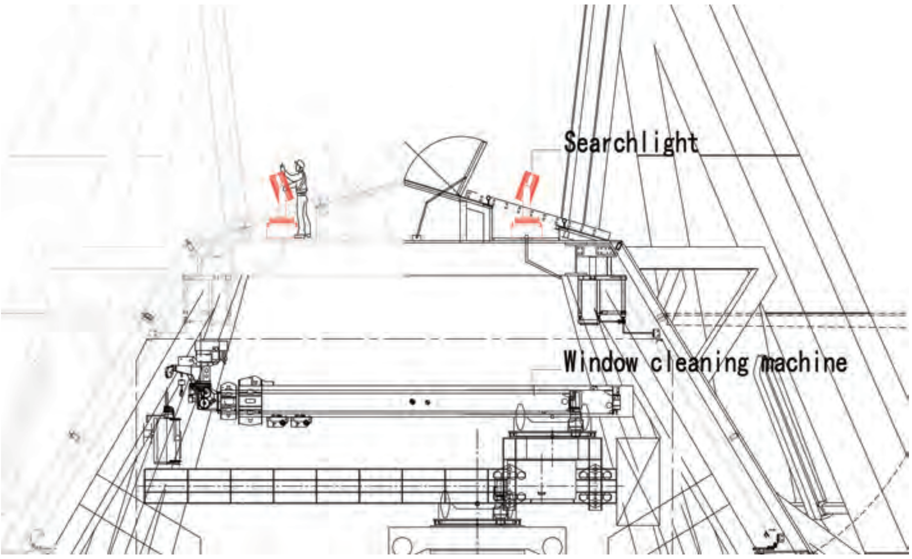

Figure 12. Sectional drawing of the layout of the searchlight fixture (Source: Beijing Fortune Lighting System Engineering Co., Ltd.)
图12. Sectional drawing of the layout of the searchlight fixture（来源：北京富润成照明系统工程有 限公司）

留吊装孔以保证灯具的顺利安装（图11、12）。

结语

超高层建筑光的筑造如同马拉松长跑，从照明设计起跑，照明深化中坚持并不断突破，在照明实施中精益求精的超越，才能迎来光明绚烂的终点。虽然不同的超高层项目会遇到不同的技术难点、施工困难，但凭借丰厚的照明深化设计积累和诸多超高层建筑照明施工经验，本着求实的心态，才能迎接并攻克每一次的挑战！

Conclusions

The lighting construction of high-rise buildings is like a marathon, starting from the lighting design, running through the lighting detailed design and implementation, and then finally arriving at the bright destination. Although different technical difficulties are always found in different high-rise projects, any challenge can be overcome based on great experiences in the lighting detailed design and the lighting construction of many high-rise building projects.