

Application of Revit Parametric Massing in Conceptual Design (Postprint)

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Abstract

This method leverages Revit's parametric massing functionality to facilitate massing study during the conceptual design phase through parameter-driven adjustments and combinations of massing forms, while enabling rapid calculation of building economic and technical indicators via extraction of mass data. Subsequently, project estimation and outdoor wind environment simulation are accomplished through data and graphic transfer from this mass model. Upon comprehensively obtaining the aforementioned data, a balance among the three datasets—economic and technical indicators, estimation metrics, and outdoor site wind environment simulation—is achieved through data correction, thereby realizing data-driven architectural design.

Full Text

Preamble

BIM Forward Design Key Technology: The Application of Revit Parametric Massing in Conceptual Design

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Abstract

This method leverages Revit's parametric massing capabilities to enable massing studies during the conceptual design phase through parameter-driven volumetric form adjustments and combinations. By extracting massing data, it rapidly calculates key building economic and technical indicators. Subsequently, through data and graphic transfer from the massing model, we achieve project cost estimation and outdoor wind environment simulation. After comprehensively

obtaining these datasets, we balance three critical parameters—economic and technical indicators, cost estimates, and outdoor wind environment simulation—through iterative data refinement, thereby realizing data-driven architectural design.

Keywords: Revit parametric massing; architectural schematic design; economic and technical indicators; outdoor wind environment simulation; cost estimation; data-driven design

Introduction

China's construction industry is currently experiencing rapid development, yet BIM technology application during the schematic design phase remains in its infancy. Presently, BIM implementation predominantly focuses on construction documentation and construction stages, falling short of comprehensive, idealized application. As building technology continues to evolve and advance, we are actively promoting BIM forward design, which will see increasingly widespread adoption in conceptual architectural design and construction. Central to BIM technology are the various parametric applications on the Revit platform. This paper explores the application of BIM parametric technology during schematic and green building design phases. Our method aims to achieve integrated cost and green building collaborative design from the earliest design stages, reducing the likelihood of later rework and fundamentally improving design efficiency. This paper also serves as a companion publication to the Guangdong Provincial Architectural Design Institute's research project, "Key Technologies for Revit Forward Design."

1. Parametric Requirements in the Design Stage

Architectural schematic design represents the most critical phase in building design—the process of concretizing and visualizing each project from nothing, refining the crude, discarding the false, and penetrating the surface to grasp the essence. It is a creative process integrating engineering, artistry, and economics, and a pivotal moment in helping clients align project planning with market demands. Economic considerations must reference design briefs and planning indicators while serving as the basis for construction cost estimation. The traditional schematic design model uses the design brief as input, specifying parameters such as floor area ratio, building coverage, total floor area, and compensatory area. Architects then approximate building forms based on these requirements before developing elevations and plans. Due to this complex workflow, schematic design consumes substantial time in iterative massing studies. When estimated costs based on the final design prove unsuitable, the scheme requires rework, further degrading design efficiency through repetitive tasks.

2. Application Value of Parameterization in the Design Stage

During the architectural conceptual design phase, employing the Revit parametric massing platform allows designers to input required volumetric dimensions and combine masses. Through Excel-based calculation of these distributed parameters, relatively specific economic and technical indicators can be obtained, saving labor, time, and material costs from the outset. Moreover, parametric capabilities on the Revit platform enable multidisciplinary collaboration during the design phase, allowing fundamental issues to be addressed comprehensively and intuitively from the initial schematic stage, thereby avoiding later repetitive rework. This method primarily resolves building form-finding challenges, assisting architects in rapidly identifying forms that satisfy both design indicators and design intent. Architects can proceed with more detailed elevation and plan design only after establishing massing expressions that meet economic indicators, green building requirements, and reasonable cost constraints, thus fundamentally preventing design rework caused by these three factors.

3. Implementation Method of Revit Parametric Massing in the Conceptual Design Phase

3.1 Design Iteration Principle with Revit Parametric Massing Models and Green Building/Cost Software

By inputting and modifying parametric models and following the workflow illustrated in Figure 1, we can rapidly obtain three datasets: economic and technical indicators, project cost estimates, and site CFD wind environment simulation results. The simulation workflow relationships are shown in Figure 1. Through continuous parameter refinement, we achieve design optimization.

[Figure 1: see original paper]

3.2 Principle for Exporting Economic and Technical Indicators from Revit Parametric Massing

By assigning corresponding parametric data and attributes to different Revit family models, the models can share parameter data and properties during the design phase, enabling Revit platform parametric massing to effectively participate in conceptual design (as shown in Figure 2).

[Figure 2: see original paper]

3.3 Parametric Design Steps for Conceptual Schemes (Using the “Xiongdi Tower Project” as Example)

First, create several “conceptual massing families” of different shapes based on design intent (Figure 3). Import these massing families into the project and input parameters to achieve desired scales for each massing model. Through

intersection and cutting operations, obtain the required overall project form (Figure 4). Then assign spatial functions to each mass, attach floor parameters and required shared parameters, and finally export the massing family parameter schedule (Figure 5).

[Figure 3: see original paper]

[Figure 4: see original paper]

[Figure 5: see original paper]

Table 1: Project Massing Parameter Schedule

3.4 Advantages, Disadvantages, and Solutions in the Revit Parametric Process

3.4.1 Advantages The “conceptual massing family” can rapidly generate floor plans through the Revit platform, which automatically calculates total floor area within the massing family. Areas for different functions or supplementary/reducible spaces can be segmented through cutting operations to ensure no duplicate calculation of the same parameter. Buildings of the same calculation type can be created using a single massing family to obtain total area sums without requiring multiple floor area 叠加 calculations.

3.4.2 Disadvantages and Countermeasures **Disadvantages:** The Revit platform cannot automatically generate floor slab schedules; it can only produce massing schedules requiring manual area summation. The system can only recognize floor areas for each individual massing family, necessitating the creation of multiple massing families for area calculations. Massing family creation may consume time and requires designers to possess a certain level of Revit proficiency. Calculation precision may not achieve the fineness of CAD 2D calculations; achieving precise values requires creating massing to a detailed level.

Countermeasures: To address the limitation of manual area summation from massing schedules, we can manually link table files using formula embedding to reduce manual effort. Given the repetitive nature of creating parametric massing models for each project, establishing a parametric massing model library would enable direct application in future projects, saving time for other project phases. Since Revit differs from traditional design software, only by improving overall software proficiency can designers better apply Revit parametric data in the conceptual design phase.

4. Methods for Outdoor Wind Environment and Project Estimation Using Revit Parametric Massing

3.2 Key Steps for Importing Revit Parametric Massing Models into CFD Software

Due to Revit's limited export formats, direct interfacing with CFD software is impossible, necessitating AutoCAD as an intermediary. Export the .rvt model to .dwg format (Figure 6), then export from AutoCAD to .iges format. Finally, import the .iges format model into CFD software.

[Figure 6: see original paper]

Using CFD software for outdoor wind environment simulation reveals that the building massing has a wind speed amplification factor of 1.55, complying with green building design standards. If the wind speed amplification factor is excessive, parametric adjustments can be made to each module in the Revit platform, and the above steps repeated to rapidly obtain updated wind environment performance for the new building massing.

[Figure 8: see original paper]

3.3 Key Steps for Importing Revit Parametric Massing Models into Excel for Estimation

By obtaining various economic and technical indicators from the Revit parametric massing model, these can be imported into a cost estimation table to derive total cost estimates, achieving data transfer. In the table, "economic indicator (yuan/m²)" is a constant, "quantity (area)" is the independent variable, and "cost (RMB: ten thousand yuan)" is the dependent variable, enabling automatic investment estimation export with each iterative optimization. The cost estimation table can be templated for future projects, allowing direct import of Revit parametric massing schedules into the estimation template for convenient application. This solves the problem of cost calculation personnel consuming substantial time and effort recalculating project costs due to schematic modifications, as illustrated in Figure 9.

[Figure 9: see original paper]

Conclusion

As architectural design is closely related to project quality, serves as the presentation of conceptual design effects, and provides the prerequisite for subsequent construction documentation and construction phases, it holds significant importance. To ensure construction projects meet basic development conditions and facilitate smooth later-stage work, Revit platform parametric massing in the conceptual phase must achieve a certain level of accuracy. Designers must create forms that satisfy project technical indicators, thereby avoiding rework

caused by non-compliant indicators, saving designers' time, energy, and financial resources. This ensures effective project timelines remain within the project cycle while safeguarding stakeholder benefits.

Leveraging new-generation software capabilities and integrating multi-software functionalities for data and graphic transfer can multiply work efficiency. Many projects face tight schematic design schedules with heavy workloads, where designers are prone to calculation errors and omissions. This method effectively mitigates these issues, achieving parameterization, automation, and computerization beyond basic data input. By delegating complex tasks to computers, designers' efficiency is improved. During parametric design implementation, clear division of labor and responsibilities between designers and budget personnel must be established to ensure work effectiveness and smooth design processes.

According to relevant surveys, the vast majority of designers currently use the SU+CAD workflow during the schematic phase. The cross-referencing between plans and elevations generates substantial repetitive work, resulting in low efficiency. Furthermore, existing schematic models cannot be effectively transferred to green building simulation phases, increasing labor costs. Adopting a parametric design approach resolves the fragmentation between economic and technical indicators, green building simulation, and cost estimation through data and graphic transfer, improving design efficiency during the architectural schematic phase and truly achieving one-model-multiple-uses.

Note: Figure translations are in progress. See original paper for figures.

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