

A Preliminary Analysis of Civil 3D and Southern CASS Applications in the Qianhai Dredging Project (Postprint)

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Abstract

China's surveying and mapping science and technology has achieved the transformation and leap from traditional surveying and mapping to digital surveying and mapping, with new technologies and new methods continuously emerging. This paper conducts a comparative evaluation of the methods for calculating dredging volumes using Southern Cass and civil3d in dredging projects.

Full Text

Preamble

On the Application of Civil 3D and Southern CASS in the Qianhai Dredging Project

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Abstract

China's surveying and mapping science and technology has achieved a transformative leap from traditional to digital methodologies, with new technologies and methods continuously emerging. This paper presents a comparative analysis of dredging volume calculation methods using Southern CASS versus Civil 3D for dredging projects.

Keywords: dredging, Civil 3D, Southern CASS, surface, earthwork calculation

Qianhai Bay is a maritime area enclosed by the Qianhai Shenzhen-Hong Kong Cooperation Zone, Bao'an Central District, and Dachan Bay Peninsula, covering a water surface area of approximately 5.4 km² with a bay mouth width of about 1 km. This project primarily involves dredging the Qianhai Bay waters with a

total area of approximately 5.4 million m². Upon completion, the project will ensure that the excavation area remains free of exposed mudflats during low tide, create a rational beach-channel layout within the bay, effectively improve the water quality environment of the Qianhai Bay area, and create conditions for building the “Qianhai Water City.”

Given the characteristics of marine construction operations, this project adopted GPS-RTK (tide-free) measurement technology. The GPS-RTK measurement system consists of a land-based base station and mobile stations in the survey area. The survey vessel collected and recorded original bathymetric data following planned survey lines perpendicular to the temporary navigation channel (with 10 m spacing between adjacent lines). According to construction contract requirements, the grid method was used for earthwork volume calculations, with Southern CASS 7.0 employed as the calculation software. During the construction phase, the project compared the performance of CASS—a traditional earthwork calculation software with secondary development on the Autodesk platform—against the three-dimensional software Autodesk Civil 3D.

2 Engineering Application Software

Currently, the primary software used for engineering earthwork volume calculations are Southern CASS and Civil 3D. CASS is a digital surveying and mapping software developed by Southern Surveying and Mapping Instrument Company based on Autodesk platform technology. It features rich landform and geographic information and is mainly applied to topographic mapping, cadastral mapping, engineering surveying, and earthwork volume calculations. Civil 3D, developed by Autodesk®, is a three-dimensional design software for the construction engineering field that imports survey data to create original 3D terrain models, grade site areas, and calculate earthwork volumes.

[Figure 1: see original paper] Original Survey Points in Southern CASS

3.1 CASS Software Calculation

The design philosophy of CASS software is based on the Digital Terrain Model (DTM), which corresponds to the “surface” concept in Civil 3D. The software uses sample lines to cut the DTM and generate original ground profiles. According to user-defined cross-section diagrams placed at the sample line positions, intersections with the original ground line are created to form cross-section lines, after which the software automatically measures the cross-sectional area and annotates it below the profile drawing. Earthwork volume calculations follow the traditional cross-section method (i.e., $[(\text{Area A} + \text{Area B})/2 \times \text{section spacing}]$, then accumulated). Using dredging data to generate a digital model as an example, the CASS software workflow involves: displaying elevation points → establishing DTM → generating triangular network → filtering triangles → generating contour lines → deleting all triangles, thereby creating a complete surface. During dredging process control, the primary earthwork calculation

method applied is the grid method, with engineering quantities calculated using Southern CASS' s 30 m \times 30 m grid method (excluding slopes and over-excavation). Based on coordinate points and elevations from vessel surveying, the original topography is generated, and the cut/fill volume is obtained by calculating the difference between two measurements (as shown in [Figure 2: see original paper]).

3.2 Civil 3D Software Calculation

[Figure 2: see original paper] Earthwork Volume Calculation in Southern CASS

The design philosophy of Civil 3D utilizes various three-dimensional data sources to construct terrain surfaces. In earthwork volume calculations, the volume represents the superposition of surfaces, calculating the Z-value difference at each elevation point using precise geometric calculation models. The main operational workflow involves: creating an empty surface \rightarrow adding digital files \rightarrow filtering unrealistic triangles in the surface properties \rightarrow displaying each point' s elevation on the drawing through Civil 3D' s data import function \rightarrow establishing a triangular network volume surface and generating a 3D model. This surface is composed of points from both the base surface and the comparison surface, providing precise differences between them. The Z-value at any point in the volume surface equals the difference between the Z-values of the comparison surface and base surface at that point. This method yields precise volume measurements between two surface definitions and generates volume reports, as shown in [Figure 3: see original paper].

[Figure 3: see original paper] Civil 3D Model and Earthwork Volume

4 Technical Strengths and Weaknesses of CASS vs. Civil 3D

CASS software has significant limitations. While it conveniently handles pure cut or pure fill scenarios, it struggles with half-cut/half-fill situations on one side of a centerline. It cannot make the lower portion of cross-sections vary according to user-defined rules (e.g., along a specific longitudinal section or at a certain elevation point), meaning it is limited to generating cross-sections from design elevation to original ground and cannot classify and statistically analyze engineering quantities.

Civil 3D offers much broader applicability, not being limited to pure cut or pure fill scenarios. Its cross-section design capabilities are powerful, and Autodesk has developed a localized package specifically tailored to Chinese design practices, allowing users to freely create desired cross-section shapes, classify generated surfaces, and statistically analyze engineering quantities.

5 Comparative Conclusions

Through the comparison of Civil 3D and Southern CASS, the following conclusions are drawn:

- 1) The most valuable aspect of Civil 3D is its three-dimensional digital terrain model. Using the DTM, users can intuitively view 3D site effects, calculate earthwork volumes, and perform longitudinal and transverse section drawings for design and calculation functions. Southern CASS offers a simple, fast, and easy-to-master calculation method. More importantly, this method simplifies procedures and significantly reduces workload, thereby substantially decreasing labor intensity for operators and improving work efficiency.
- 2) Civil 3D provides multiple calculation methods for earthwork volumes, but its unique surface composite algorithm enables volume calculations directly through terrain models, making it more suitable for large-scale, detailed earthwork calculations.
- 3) Southern CASS can calculate earthwork volumes in a single operation for design surfaces or post-construction surfaces that are not on the same plane, offering extensive practical application value. Civil 3D provides designers with rich and powerful design tools that greatly improve design efficiency, while also imposing higher requirements on surveying and mapping. Traditional two-dimensional graphic data can no longer meet the needs of design departments; providing three-dimensional data directly applicable to design is an urgent necessity and an inevitable future trend.

Autodesk Civil 3D software, as a new civil and infrastructure construction software, is increasingly widely applied in these fields due to its superiority, though continuous improvement in production practice remains necessary.

References

- [1] Application of Autodesk Civil 3D in Land Development Engineering [Journal Article] *Science and Technology Outlook*, 2016, Mei Changqing
- [2] Analysis of Common Earthwork Volume Calculation Methods [Journal Article] *Construction Engineering Technology and Design*, 2016, Li Quanxing
- [3] Analysis of Autodesk Civil 3D Application in Road Design and Construction Surveying [Journal Article] *Urban Construction Theory Research (Electronic Edition)*, 2012, Liu Zijian
- [4] Algorithm and Program for Calculating Corresponding Centerline Mileage from Arbitrary Point Coordinates [Journal Article] *Shanxi Architecture*, 2008, Huang Xinzan
- [5] Zhang Yuan. Research on Three-Dimensional General Layout Design Theory and Its Application [D]. Xi'an University of Architecture and Technology, 2009.

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