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BIM-BASED STEEL QUANTITY TAKE-OFF EVALUATION FOR STEEL FRAME BRIDGES: A COMPARISON BETWEEN AUTODESK REVIT AND CONVENTIONAL CALCULATIONS

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Abstract
Building Information Modeling (BIM) has become an effective approach for improving the efficiency and accuracy of quantity take-off (QTO) in construction projects, including steel truss bridges. This study evaluates the accuracy of steel weight quantity take-off generated using Autodesk Revit 2025 by comparing it with conventional calculations based on the Detail Engineering Design (DED). The comparison was conducted on 34 steel profile groups consisting of 210 structural members. Steel weight obtained from Autodesk Revit was compared with conventional calculations using percentage difference and statistical indicators, including Mean Error (ME), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and the Coefficient of Determination (R^2). The results show that Autodesk Revit produced a total steel weight of 27,526.57 kg, while the conventional calculation yielded 27,478.92 kg, resulting in a percentage difference of only 0.17%. The statistical evaluation produced an ME of 1.40 kg, an MAE of 9.31 kg, a MAPE of 1.89%, and an R^2 value of 0.9996, indicating excellent agreement between the two methods. Unlike previous studies that mainly compared total quantities, this study evaluates steel weight quantity take-off at the individual profile level, providing a more detailed assessment of Autodesk Revit accuracy for steel truss bridge structures. The findings demonstrate that Autodesk Revit 2025 is a reliable and effective tool for BIM-based steel quantity take-off.

Keywords: ***Autodesk Revit 2025; Building Information Modeling (BIM); Quantity Take-Off; Steel Truss Bridge; Steel Weight; Structural Framing.***

INTRODUCTION

The construction industry has experienced rapid digital transformation through the implementation of Building Information Modeling (BIM), which integrates geometric, engineering, and project information into a single digital environment, enabling more effective collaboration among project stakeholders. (Abma et al., 2026). BIM also supports automatic Quantity Take-Off (QTO) by extracting material quantities directly from three-dimensional models, thereby reducing manual calculations and improving the consistency of quantity estimation. (Dwi Nur Wahyudi & Masca Indra Triana, 2025) In steel bridge construction, accurate quantity estimation is essential because structural steel represents one of the largest cost components and directly affects procurement planning, fabrication, and project budgeting. Conventional quantity estimation is generally performed manually using two-dimensional drawings and steel profile tables, making the process time-consuming and prone to human error. (Saputra et al., 2024).

Autodesk Revit has become one of the most widely adopted BIM platforms for structural modeling and quantity take-off because it automatically generates schedules containing dimensions, volumes, and material quantities from digital models. Previous studies have shown that BIM-based quantity take-off provides more efficient and consistent results than conventional calculations. (Dwi Nur Wahyudi & Masca Indra Triana, 2025; Stefanus & Lutfiansyah, 2025). (Abma et al., 2026) further reported that automated quantity take-off can improve contractors' productivity in bridge projects, although the quality of the BIM model significantly influences the accuracy of the generated quantities.

Despite these developments, most previous studies have focused on comparing total quantities or evaluating BIM implementation in concrete bridge or building structures. Detailed evaluations of the accuracy of steel weight quantity take-off for each structural steel profile remain limited. (Abma et al., 2026; Stefanus & Lutfiansyah, 2025; Tigauw et al., 2023). Consequently, there is still limited evidence regarding the consistency of Autodesk Revit in estimating the weight of individual steel members used in steel truss bridges. Therefore, this study evaluates the accuracy of steel weight quantity take-off generated using Autodesk Revit by comparing it with conventional calculations based on Detail Engineering Design (DED) documents.

LITERATURE REVIEW

Building Information Modeling (BIM) has become one of the most significant digital innovations in the Architecture, Engineering, and Construction (AEC) industry by integrating geometric, physical, and project information into a single digital model. Compared with conventional methods, BIM enables better collaboration among stakeholders while improving the accuracy and efficiency of planning, design, and construction processes. One of the most widely implemented BIM applications is Quantity Take-Off (QTO), which automatically generates material quantities from three-dimensional models, thereby reducing manual calculations and minimizing human errors (Abma et al., 2026; Dwi Nur Wahyudi & Masca Indra Triana, 2025)

Autodesk Revit is one of the BIM software applications commonly used for structural modeling and automated quantity take-off. Through the Schedule/Quantities feature, Revit provides detailed information regarding the dimensions, volumes, and weights of structural elements directly from the digital model. Previous studies have demonstrated that BIM-based quantity take-off produces results comparable to conventional calculations while significantly improving work efficiency. Tigauw et al. (2023) reported that Autodesk Revit successfully reduced the time required for quantity estimation in bridge projects, whereas Stefanus & Lutfiansyah (2025) concluded that BIM-based quantity calculations provide reliable results for bridge construction with only minor differences compared to conventional methods.

Despite these developments, previous studies have mainly focused on evaluating total quantities or comparing construction costs between BIM and conventional approaches. Detailed investigations into the accuracy of steel weight estimation for each structural profile in steel truss bridges remain limited. Variations in profile geometry and structural functions may affect the accuracy of automated quantity take-off, yet these aspects have received little attention in previous research. Therefore, this study evaluates the accuracy of steel weight quantity take-off generated using Autodesk Revit by comparing it with conventional calculations for each steel profile. This approach provides a more comprehensive assessment of BIM reliability for steel truss bridge quantity estimation.

METHOD

This study employed a quantitative comparative approach to evaluate the accuracy of steel weight quantity take-off generated using Autodesk Revit compared with conventional calculations. The research object was a steel truss bridge designed based on the Detail Engineering Design (DED) documents. The bridge superstructure consisted of various steel members, including bottom chords (BC), diagonals (DG), top chords (TC), cross girders (CG), bracing members (BR), and stiffeners (ST). The conventional steel weight obtained from the DED served as the reference for evaluating the accuracy of the BIM-based quantity take-off.

The research was conducted in four stages. The first stage involved collecting secondary data, including structural drawings, steel profile specifications, and conventional quantity calculations from the DED documents. The second stage consisted of developing a three-dimensional BIM model of the steel truss bridge using Autodesk Revit 2025. Each structural member was modeled according to its dimensions, profile type, and length specified in the design drawings. After the model was completed, the Schedule/Quantities feature was used to automatically extract the steel weight for each structural profile.

The third stage involved comparing the steel weight generated by Autodesk Revit with the conventional calculation results. The comparison was carried out for each steel profile based on the quantity, member length, steel weight, weight difference, and percentage error. The percentage error was calculated using Equation (1).

$$Error\ (\%) = \frac{W_{Revit} - W_{Conv}}{W_{Conv}} \times 100\%$$

where W_{Revit}represents the steel weight obtained from Autodesk Revit and W_{Conv}represents the steel weight calculated using the conventional method. The final stage involved analyzing the comparison results to determine the accuracy of Autodesk Revit in estimating steel quantities. The analysis focused on the magnitude of the weight differences and percentage errors for each steel profile, followed by an evaluation of the total steel weight difference between the BIM model and the conventional calculation.

Table 1. Bridge Specifications

Parameter	Description
Bridge type	Steel truss bridge
BIM software	Autodesk Revit 2025
Quantity analysis	Steel weight (kg)
Number of steel profiles	35 profile groups
Total structural members	210 members
Total steel weight (Conventional)	27.478,92 kg
Total steel weight (Revit)	27.526,57 kg

RESULTS AND DISCUSSION

Comparison of Steel Weight Quantity Take-Off

The steel weight quantity take-off generated using Autodesk Revit was compared with the conventional calculation obtained from the Detail Engineering Design (DED). The comparison was performed on 35 steel profile groups consisting of 210 structural members. The evaluated parameters included the steel weight generated by Autodesk Revit, the conventional steel weight, the weight difference, and the percentage error for each steel profile.

Table 2. Comparison of Steel Weight Quantity Take-Off

Type	Qty	Length (mm)	Revit (Kg)	Conventional (Kg)	Difference (Kg)	Error (%)
BC-1 H 400X400X10X12	4	4.850	510,25	506,07	4,18	0,83
BC-2 H 400X400X10X10	4	4.990	463,15	462,25	0,90	0,19
BC-3 H 400X450X12X14	4	4.990	667,25	668,44	-1,19	-0,18
BC-4 H 400X450X12X20	4	4.990	871,35	874,32	-2,97	-0,34
BC-5 H 400X450X14X20	4	4.990	902,75	902,50	0,25	0,03
DG-1 H 400X520X12X18	4	6.290	1.138,25	1.111,14	27,11	2,44
DG-2 H 400X400X12X18	4	6.290	926,30	912,36	13,94	1,53
DG-3 H 400X430X12X18	4	6.290	981,25	963,13	18,12	1,88
DG-4 H 400X380X8X14	4	6.290	675,10	662,63	12,47	1,88
DG-5 H 400X430X8X16	4	6.290	824,25	809,57	14,68	1,81
DG-6 H 400X380X8X12	4	6.290	596,60	590,53	6,07	1,03
DG-7 H 400X380X8X14	4	6.290	675,10	663,22	11,88	1,79
DG-8 H 400X350X8X10	4	6.290	494,55	490,17	4,38	0,89
DG-9 H 400X350X8X12	4	6.290	565,20	556,81	8,39	1,51
DG-10 H 400X300X8X8	4	6.290	392,50	385,91	6,59	1,71
TC-1 H 400X420X12X16	4	5.008	698,65	701,99	-3,34	-0,48
TC-2 H 400X400X12X16	4	5.008	675,10	676,81	-1,71	-0,25
TC-3 H 400X450X12X20	4	5.008	879,20	877,45	1,75	0,20
TC-4 H 400X450X16X22	4	5.008	1.004,80	1.002,29	2,51	0,25
TC-5 H 400X420X12X16	4	5.008	1.012,65	1.012,76	-0,11	-0,01
CG1-1 H 975X300X12X25	2	9.140	2.001,75	2.030,40	-28,65	-1,41
CG1-2 H 975X300X12X25	2	9.134	1.993,90	1.988,08	5,82	0,29
CG1-3 H 975X300X12X25	2	9.142	2.001,75	1.989,72	12,03	0,60
CG1-4 H 975X300X12X25	2	9.142	2.001,75	1.989,72	12,03	0,60
CG1-5 H 975X300X12X25	3	9.146	2.009,60	1.990,54	19,06	0,96
BR1-1 H 400X200X8X13	2	9.140	745,75	752,63	-6,88	-0,91

Type	Qty	Length (mm)	Revit (Kg)	Conventional (Kg)	Difference (Kg)	Error (%)
BR2-1 H 150X150X7X10	2	9.967	306,15	313,96	-7,81	-2,49
BR2-2 H 150X150X7X10	2	4.712	141,30	148,44	-7,14	-4,81
BR2-3 H 150X150X7X10	7	10.175	314,00	320,51	-6,51	-2,03
BR2-4 H 150X150X7X10	16	4.935	149,15	155,45	-6,30	-4,05
ST2-1 H 300X150X6.5X9	4	4.968	180,55	196,86	-16,31	-8,29
ST2-2 H 300X150X6.5X9	16	4.970	180,55	196,86	-16,31	-8,29
ST1-1 H470X170X8X10	14	4.968	273,02	287,70	-14,68	-5,10
ST1-2 H470X170X8X10	56	4.970	273,10	287,70	-14,60	-5,07
Total	**210**	**217.259**	**27.526,57**	**27.478,92**	**47,65**	**0,17**

Note: Positive values indicate that the steel weight generated by Autodesk Revit is greater than the conventional calculation, while negative values indicate lower values.

Based on Table 2, Autodesk Revit generated a total steel weight of 27.526,57 kg, while the conventional calculation resulted in 27.478,92 kg. The difference between the two methods was 47.65 kg, corresponding to an overall error of only 0.17%. This result demonstrates that Autodesk Revit can estimate the steel weight of a steel truss bridge with a very high level of accuracy. To provide a clearer overview of the comparison results, the overall quantity take-off summary is presented in Table 3.

Table 3. Summary of Steel Weight Comparison

Parameter	Value
Number of steel profile groups	34
Number of structural members	210
Total steel weight (Autodesk Revit)	27.526,57 kg
Total steel weight (Conventional)	27.478,92 kg
Weight difference	47.65 kg
Total error	**0.17 %**

The results presented in Table 3 indicate that the total difference between Autodesk Revit and the conventional calculation is relatively insignificant. The total error of 0.17% suggests that the BIM-based quantity take-off provides results that are highly consistent with the conventional method and can therefore be considered reliable for estimating steel quantities in steel truss bridge projects.

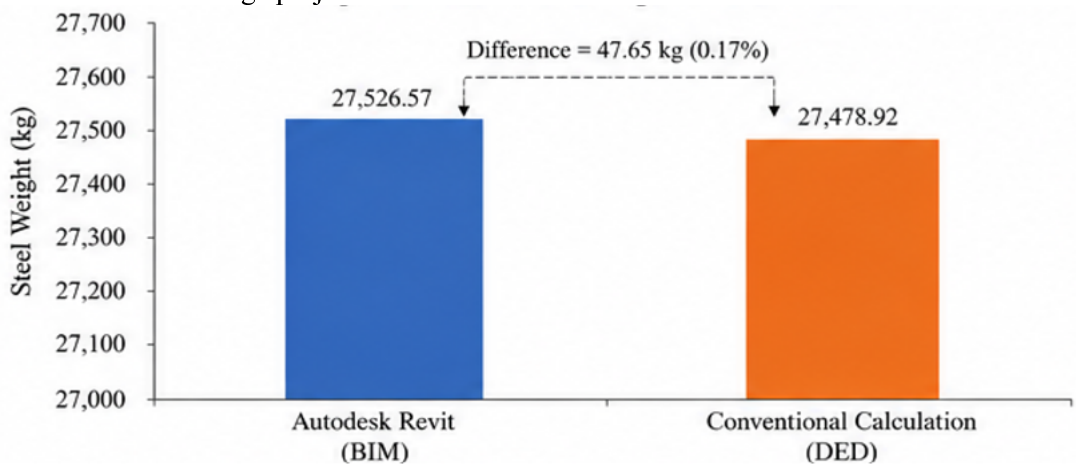

Image 1. Comparison of Total Steel Weight

To visually compare the total steel weights obtained from both methods, Image 1 presents the comparison of the total steel weight generated by Autodesk Revit and the conventional calculation. Image 1 shows that the total steel weights obtained from Autodesk Revit and the conventional calculation are nearly identical, confirming the high accuracy of BIM-based quantity take-off.

Statistical Evaluation of Quantity Take-Off Accuracy

To further evaluate the agreement between Autodesk Revit and the conventional calculation, several statistical indicators were employed, including Mean Error (ME), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and the Coefficient of Determination (R^2). The statistical evaluation results are summarized in Table 4.

Table 4. Statistical Evaluation of Steel Weight Quantity Take-Off

Indicator	Value	Interpretation
Mean Error (ME)	1.40 kg	Autodesk Revit slightly overestimates the steel weight compared with the conventional calculation.
Mean Absolute Error (MAE)	9.31 kg	The average absolute difference between both methods is relatively small.
Mean Absolute Percentage Error (MAPE)	1.89 %	The average percentage deviation indicates high quantity take-off accuracy.
Coefficient of Determination (R^2)	0.9996	Very strong agreement between Autodesk Revit and the conventional calculation.

The statistical evaluation further confirms the accuracy of Autodesk Revit in estimating steel quantities. The Mean Error (ME) of 1.40 kg indicates a slight tendency for Autodesk Revit to overestimate the steel weight compared with the conventional calculation. Meanwhile, the Mean Absolute Error (MAE) of 9.31 kg demonstrates that the average absolute difference between the two methods is relatively small for each steel profile. Furthermore, the Mean Absolute Percentage Error (MAPE) of 1.89% indicates that the average deviation remains below 2%, which is generally considered acceptable for engineering quantity estimation. The Coefficient of Determination ($R^2 = 0.9996$) reveals an almost perfect linear relationship between Autodesk Revit and the conventional calculation, confirming the high consistency and reliability of BIM-based steel quantity take-off.

Analysis of Percentage Error

Although the total steel weight difference was relatively small, variations were observed among several structural members. Most steel profiles showed percentage errors below ±2%, indicating excellent agreement between Autodesk Revit and the conventional calculation. The Bottom Chord (BC) members exhibited the smallest deviations, with percentage errors ranging from −0.34% to 0.83%, indicating excellent agreement between Autodesk Revit and the conventional calculation. Similarly, the Top Chord (TC) members showed very small deviations, ranging from −0.48% to 0.25%. The Diagonal (DG) members produced slightly higher deviations, with percentage errors ranging from 0.89% to 2.44%. Nevertheless, these values remain within an acceptable range for engineering quantity estimation. The Cross Girder (CG) members exhibited percentage errors between −1.41% and 0.96%, while the Bracing (BR) members ranged from −4.81% to −0.91%. The largest deviations were observed in the Stringer (ST) members, where the percentage error ranged from −8.29% to −5.07%. These differences are likely associated with profile definitions, modeling assumptions, or rounding during conventional calculations. However, because the stringers contribute only a relatively small proportion of the total bridge steel weight, these deviations have minimal influence on the overall quantity estimation.

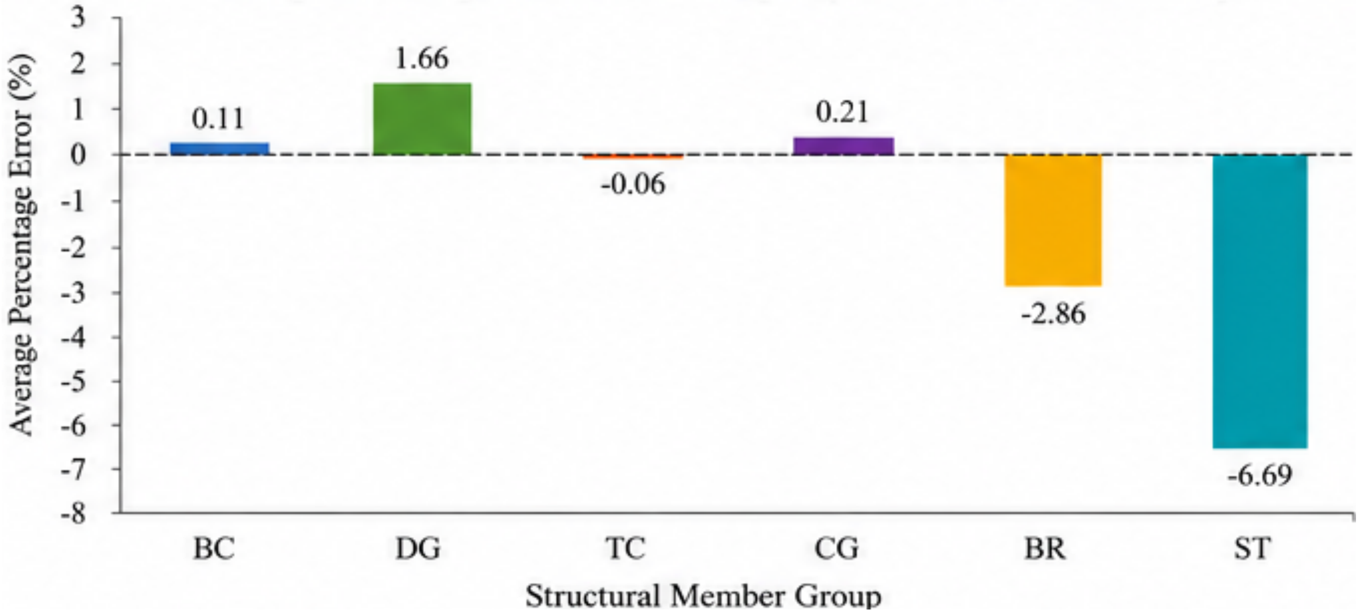

Image 2. Average Percentage Error by Structural Member Group

The figure shows that most structural members have relatively small deviations, while larger differences are concentrated in the Stringer members. This observation suggests that Autodesk Revit provides more consistent quantity estimation for the primary structural members than for the secondary members.

Discussion

The comparison results indicate that Autodesk Revit can generate steel quantity take-off with a high degree of accuracy. The overall error of only 0.17% confirms that the steel weights extracted directly from the BIM model are practically equivalent to those obtained through conventional calculations. This finding is consistent with previous studies by Tigauw et al. (2023), which reported that BIM-based quantity take-off improves efficiency while maintaining acceptable calculation accuracy. Similar conclusions were also reported by Stefanus & Lutfiansyah (2025), who found that Autodesk Revit produces quantity estimation results comparable to conventional methods for bridge construction. The observed differences between Autodesk Revit and the conventional calculation are likely influenced by several factors. First, Autodesk Revit determines steel weight automatically based on the geometric properties and material parameters assigned to each modeled element. In contrast, conventional calculations generally rely on theoretical unit weights obtained from steel profile tables. Small differences in section properties, profile libraries, or assigned material densities may therefore produce slight discrepancies in the calculated steel weight.

Second, modeling accuracy also affects the quantity take-off results. Structural members with relatively simple geometry, such as the Bottom Chord, Diagonal, Top Chord, and Cross Girder, demonstrated excellent agreement between the two methods. Conversely, the larger deviations observed in the Stringer members may be attributed to differences in profile dimensions, connection details, or simplifications applied during BIM modeling. Although these deviations reached approximately 8% for individual members, their influence on the total bridge steel weight remained negligible because the stringers constitute only a small proportion of the entire steel structure. From a practical perspective, the findings demonstrate that Autodesk Revit is capable of providing reliable quantity information while significantly reducing manual calculation efforts. The automatic generation of steel quantities facilitates faster preparation of Bills of Quantity (BOQ), minimizes human errors, and improves data consistency throughout the design process. Consequently, Autodesk Revit can be considered an effective tool for quantity take-off in steel truss bridge projects, provided that the BIM model accurately represents the actual bridge geometry and structural properties.

CONCLUSION

This study evaluated the accuracy of steel weight quantity take-off generated using Autodesk Revit 2025 by comparing the results with conventional calculations for a steel truss bridge. The comparison was conducted on 34 steel profile groups consisting of 210 structural members. Autodesk Revit produced a total steel weight of 27.526,57 kg, while the conventional calculation yielded 27.478,92 kg, resulting in a total difference of 47.65 kg or 0.17%.

These results indicate that Autodesk Revit is capable of providing highly accurate steel quantity estimation for steel truss bridge structures. The statistical evaluation further confirmed the reliability of the BIM-based quantity take-off. The Mean Error (ME) of 1.40 kg indicates only a slight tendency for Autodesk Revit to overestimate steel weight. The Mean Absolute Error (MAE) of 9.31 kg and Mean Absolute Percentage Error (MAPE) of 1.89% demonstrate that the average deviation between Autodesk Revit and the conventional calculation is relatively small. Furthermore, the Coefficient of Determination (R^2) of 0.9996 indicates an almost perfect correlation between the two methods, confirming the consistency and accuracy of Autodesk Revit in estimating steel quantities.

The findings also reveal that the primary structural members, namely the Bottom Chord, Diagonal, Top Chord, and Cross Girder, exhibited relatively small percentage errors, whereas larger deviations were observed in the Bracing and Stringer members. However, these deviations contributed only marginally to the total bridge steel weight and therefore did not significantly affect the overall quantity estimation. Unlike previous studies that primarily compared total steel quantities, this study evaluated the accuracy of steel weight quantity take-off at the individual profile level, enabling a more detailed assessment of Autodesk Revit performance for each structural member of a steel truss bridge. This profile-based evaluation provides additional insight into the distribution of quantity deviations and can support more effective verification of BIM-generated quantity take-off results. Based on these findings, Autodesk Revit 2025 can be considered a reliable and effective tool for steel weight quantity take-off in steel truss bridge projects. Future research is recommended to expand the scope of BIM-based quantity take-off by including secondary steel components, such as gusset plates, splice plates, base plates, bolts, welds, and other connection elements, to obtain a more comprehensive estimation of total steel quantities.

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