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Implementation of Building Component Drawing Automation to Enhance Time Efficiency and Accuracy in the Construction Planning Process

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Keywords

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Abstract

The use of automation in drawing within AutoCAD® based on NET C# is one solution for time efficiency and accuracy in building component drawings. Typically, AutoCAD® follows a command syntax concept of one command for one object (usual command, UC) in building component drawings. However, utilizing automation in AutoCAD® based on NET C# allows a single command syntax to be applied to multiple objects, generating multiple outcomes (automatic command, AC). Through this automation, typical drawings can be created by inputting data in a form and executing it with a single button click, resulting in the immediate creation of typical drawings. The automation of building component drawings aims to enhance time efficiency and accuracy in drawing. The research methodology employs a quantitative approach with a comparative design between two paired samples. A comparative study was conducted with 10 respondents, allowing them to draw building components using two methods: UC and a second method using AC. The time taken for drawing using UC and AC was recorded, and from the recorded time data, an analysis of time efficiency and drawing accuracy was performed. Time analysis was conducted using IBM SPSS 26 and Excel applications. The analysis procedure used a paired sample two-tailed t-test with the condition that if the sig. value < 0.05, then H0 is rejected and Ha is accepted, or if the calculated t-value > tabulated t-value, then H0 is rejected and Ha is accepted. The analysis results revealed a significant difference in time efficiency between the usual command (UC) and automatic command (AC) methods. During the testing process, accuracy testing of the automation program was also conducted, yielding high accuracy results for the automation program. The research findings indicate that the implementation of automation in drawing based on AutoCAD® and NET C# significantly contributes to enhancing time efficiency and accuracy in building component drawings.

1. Introduction

Construction management is the process of planning, organizing, controlling, and supervising all aspects involved in the implementation of a construction project. Construction management includes the management of human resources, financial resources, material resources, project time and risk. The main objective of construction management is to ensure construction projects are completed efficiently, effectively, and in accordance with the established requirements (Sahid, 2017).

The planning process in construction management is the initial and critical step in organizing and directing the course of a construction project. At this stage the pre-design concept is transformed into a detailed and practical plan that can be used for project execution. The planning process involves developing in-depth technical designs for various aspects of the project, such as structural works, mechanical works, electrical works, and other civil works. It is also at this stage that the process of describing in detail the structural components, electrical systems, mechanical systems, and all other technical aspects related to the construction project is carried out.

The development of the pre-design stage will produce technical drawings, diagrams (gant charts, S curves, and others), and documentation that provides a detailed explanation of construction design and technical specifications. Drawing layouts and design details through the use of computer-aided design (CAD) software such as AutoCAD® has become an important requirement for planning consultants. AutoCAD® is a software product from AutoDesk® is the main choice for many planning consultants because of its proven ability to produce technical drawings with complete drawing tools, and also provides opportunities for users to customize and automate tools that can increase the efficiency of drawing time optimally.

In this case, the efficiency of the drawing time will have an impact on the total time required for the completion of the entire work item in the consultant contract. It often happens, the duration of completion of consultant contracts is relatively short because it is related to the grace period for physical auction of construction which must be completed within 1 (one) current fiscal year. The short duration of the consultant's work is certainly very influential on the accuracy of drawing, especially if the drawing done on AutoCAD® only uses single commands from the available tools. In addition, there are also often errors in the drawing looping process due to the use of copy-paste commands from the same detailed image but with different dimensions.

Moving on from the description above, in this study an automation program was developed in AutoCAD® based on NET API C # for the looping process of drawing details of special typical drawings, in this case including detailed depictions of building components, namely: continuous foundation, local tread foundation details, reinforced concrete details, roof details, portal cut details. Automation that is designed by simply changing a certain size or description will immediately generate detailed images automatically.

The use of AutoCAD® automation for drawing building components is expected to make the drawing process more efficient in terms of time, cost and accuracy in construction planning.

The purpose of this study is how to implement drawing automation using AutoCAD NET-based automation programs, how to compare (compare) time efficiency using the drawing method with automatic command (AC) compared to the drawing method with the default AutoCAD®® command (usual command), and the reasons for the difference (comparative) in drawing using the AC method with UC.

Based on the analysis described above, the problem formulation is made as steps in compiling research so that it is structured, organized and schematic, as for the problem formulation in the study, namely How does the effect of drawing automation on time efficiency, accuracy and how much time efficiency level uses automation drawing? How can the procedure for implementing drawing automation be applied? How to compare (comparative) drawing using automation with AutoCAD® built-in commands (usual command)?.

2. Materials and Methods

The research method used is to use quantitative research methods because it is related to data processing in the form of numbers, namely processing time efficiency analysis, especially processing time analysis of drawing implementation using automation (automatic command) compared (comparative) with drawing using the drawing method using default commands in AutoCAD® (usual command, UC). For quantitative research designs, comparative design models are used, namely, comparing two samples in pairs, comparing the efficiency of the usual command (UC) drawing time with the efficiency of the next automatic command (AC) drawing time for data processing analysis with the help of SPSS application analysis and using Excel applications.

Data collection of building components is carried out at the consulting company CV. Graha Karya Consultant located in Asir-Asir Atas Takengon Village, Lut Tawar District, Central Aceh Regency. Drawings of reinforced concrete building components are the work of Detail Engineering Design (DED) SDN 10 Bebesen, Lut Tawar District, Central Aceh Regency, the DED building component drawing items will be used as material for the implementation of drawing using AutoCAD® software both by automatic command (AC) and by usual command (UC), for DED drawings listed in APPENDIX C: Building Component Drawings.

3. Results and Discussions

Building Component Drawing Automation

Drawing building components using AutoCAD 2019, after AutoCAD®® opens, a palette display will appear containing along with *button* names of commands from automation programs, drawing scenarios, by implementing building components in Appendix C: Building Component Drawings, to be carried out the implementation of drawing either using the *usual command* (UC) method or using *the automatic command method* (AC), the initial view of automation can be seen in figure 4.1 below.

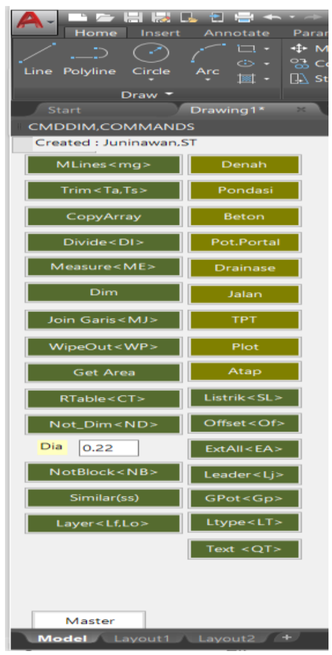


Figure 3.1 Initial display of program automation

Building Component Drawing Automation

Typical details

Typical details are detailed depictions of building components, such as detailed depictions of reinforced concrete, continuous foundation details, local tread foundation details, light steel easel details and portal cut details, in the discussion below will be described one by one the use of features and discussions.

Details of reinforced concrete

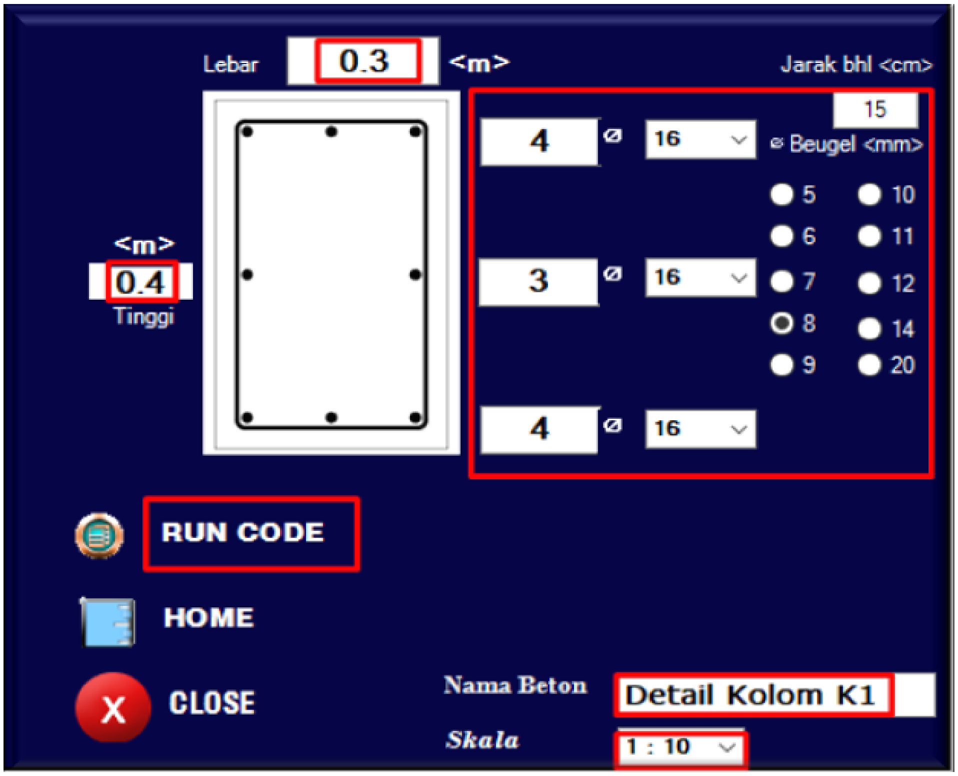


Figure 4.2 Use of automation *features of reinforced concrete*

As previously explained about making column plan plans, there are 3 types of k1 column types with a size of 30 x 40 centimeters, k2 columns with a size of 20 x 30 centimeters, k3 columns measuring 13 x 13 centimeters, then click the *concrete button* on the Palette menu. For the manufacture of k1 columns, input 0.3 meters wide and 0.4 meters high, then input the number of upper, middle and lower reinforcing iron and select the dimensions of the iron size, select the diameter of the begel iron and the distance between the begels, input the name of the concrete title, select the scale of the image and then click the run code button then the program will ask for the position of the concrete detail place, click the coordinates of the concrete laying and finally the automation program will create a detailed concrete drawing complete with size, Layer names repeat for columns of other types as well as for details of sloof, blocks. For details see the image below.

Making concrete details is done by *inputting* data on the *form* after all the data is *inputted* then by pressing the "RUN CODE" button the automation program will ask for the location of the concrete detail drawing, by clicking any point the drawing will be directly created in AutoCAD® 2019 for the results of using the reinforced concrete feature can be seen in figure 4.81 below.

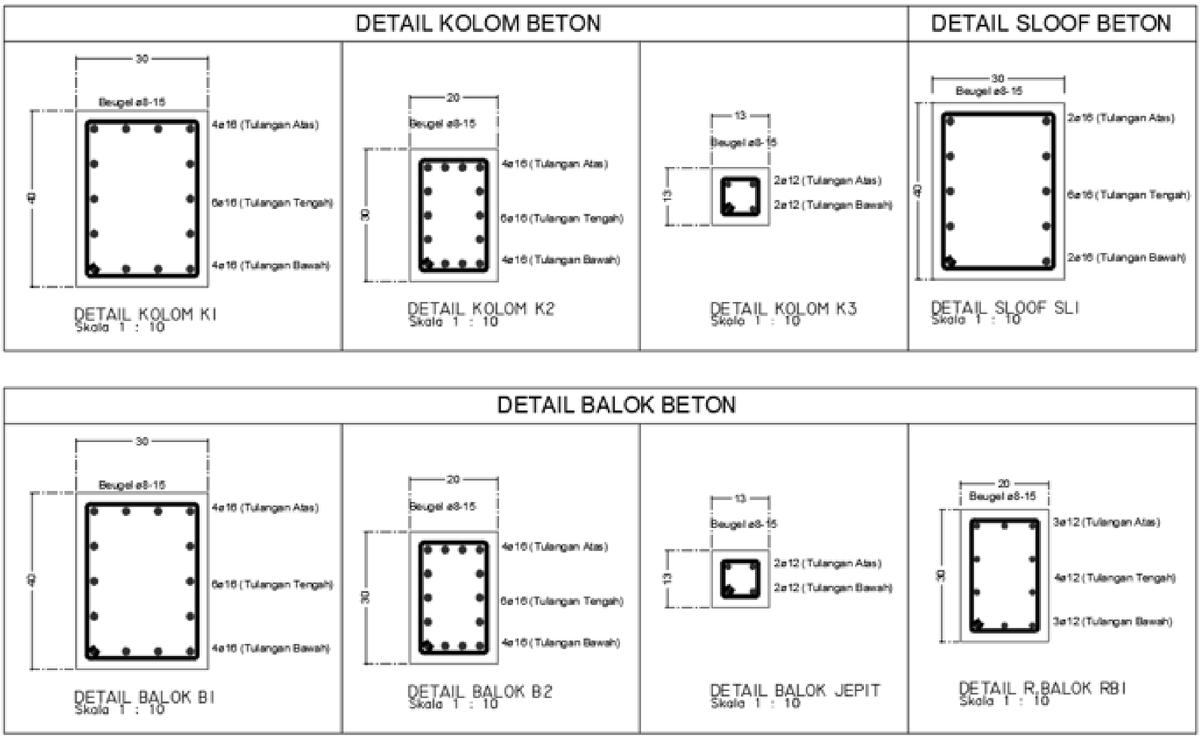


Figure 4.3 Concrete detail finish automation *concrete features*

Continuous foundation details

A screenshot of a computer Description automatically generated*Gambar 4.67 Penggunaan* Automasi *garis potongan (Gpot)* ada 2 jenis tipe pondasi yakni tipe p1 dan p2, tipe p1 dengan ukuran lebar bawah pondasi 80 cm, lebar atas pondasi 40 cm dan ketinggian pondasi 80 cm, sedangkan untuk tipe p2 lebar bawah pondasi 70 cm, lebar atas pondasi 35 cm dan ketinggian pondasi 70 cm. untuk tipe *p1A* hanya perubahan ketinggian elevasi lantai dengan selasar, selasar lebih rendah 5 centimeter dari ruangan. Klik tombol pondasi pada *Palette* pilih *pondasi menerus* pada *menu strip*, selanjutnya *input* data untuk pondasi tipe *p1-A (*lihat gambar di bawah ini).

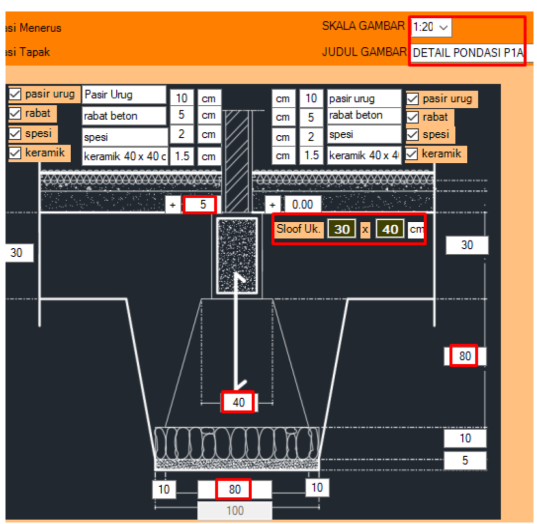


Figure 4.4 Data *form Input* on *continuous foundation feature*

For filling foundation type type p1, p2 resize adjust in centimeters, change the scale as needed, change the title of the foundation type drawing then press the "RUN CODE" button and *insert* the foundation base *point*. The time required for one type of continuous foundation is 2 seconds for 3 types of continuous foundation the total time is 6 seconds**.**

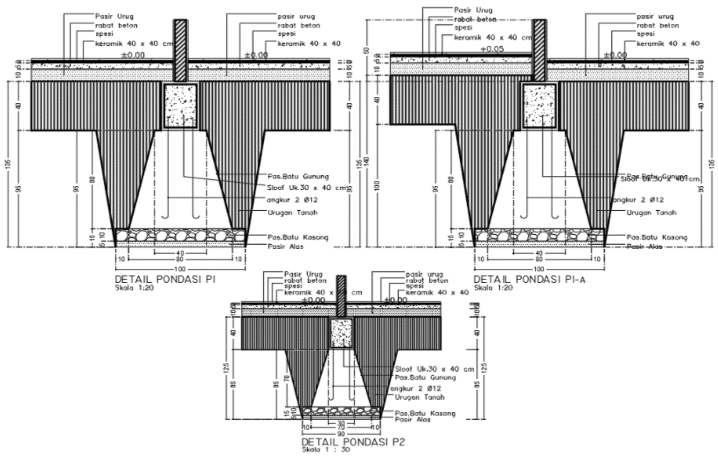


Figure 4.5 Results of *continuous foundation feature automation*

The use of the continuous foundation feature is very helpful in depicting building components, because only with *the input of* foundation size data and the scale of the drawing, the results are directly presented in AutoCAD® accompanied by creating *layers* for each line including making *hatches* for each type of item. If using manual in AutoCAD® will take a lot of time sometimes due to chasing time *users* often *copy* and *paste* from previous drawings just by resizing without changing the drawings, this often occurs in the field during construction work, due to blurred drawings unclear size, finally the *project manager* measuring with meters and there is a size error in continuous foundation work. For the calculation of the running of the program is the same as the discussion *of reinforced concrete details*, for filling *out the form* if there is data filled with *text* that should be numbers will not be able to be *input* so that anticipate errors, if there is empty data the program automation will notify there is empty data.

Local tread foundation details

A computer screen shot of a building Description automatically generated*detail* tapak setempat di atas lebih rumit dari pembuatan *detail* pondasi menerus, mulai dari pengaturan jarak begel, jarak antara besi tapak, pemberian *layer* ke masing-masing garis dan *hatch* akan memakan waktu yang banyak jika menggunakan cara-cara manual, dengan menggunakan automasi penggambaran hanya perubahan *input* data dan keterangan maka gambar akan langsung jadi di AutoCAD® disertai pilihan skala gambar, dimensi, nama *layer*, pemberian keterangan *leader* gambar, pemberian *hatch* dan lain sebagainya secara otomatis dibuat oleh automasi.

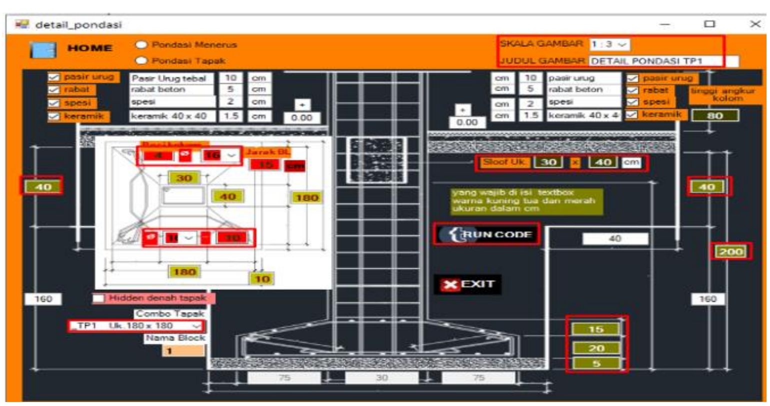


Figure 4.87 Automated use of *local tread foundation features*

In figure 4.87 above the filling steps for *the local tread foundation input form, if previously it has been inputted the width and height of the local* tread foundation plan, just select in the site combo the type of local tread foundation then the *size of the tread plan will adjust* the initial input, *then on the* form The figure above 4 ø 16 is for the amount of column iron along with the diameter of the iron which can be seen in the manufacture of reinforced concrete details (columns).

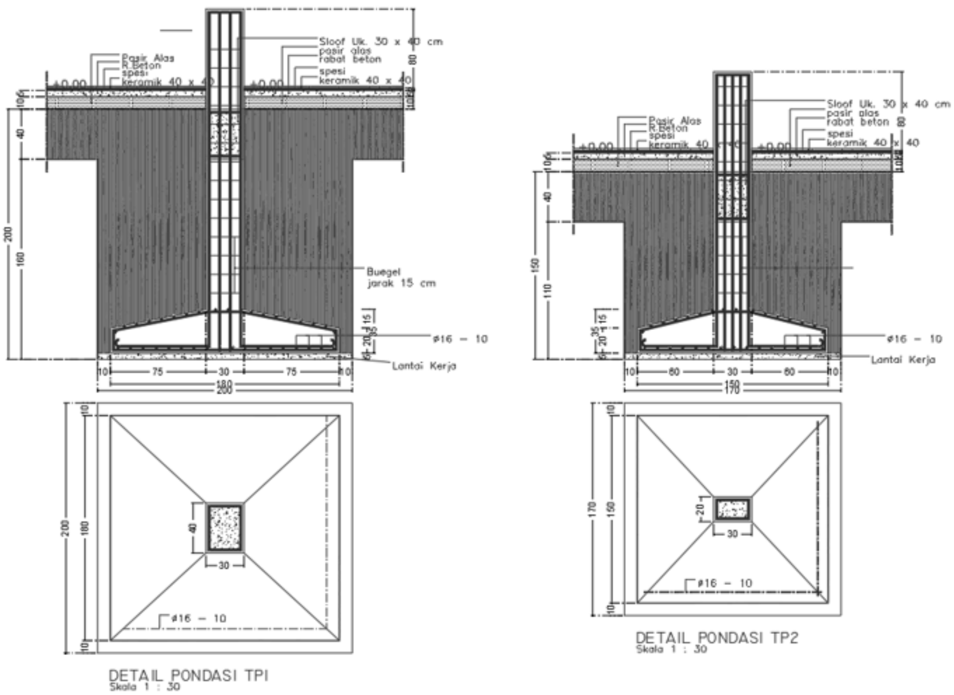


Figure 4.6 Local site feature *automation results*

Details of the light steel easel

Automate the *detail features* of the light steel easel, on the Palette *menu by clicking the roof button*, then select the mild steel strip menu, *input the roof width data divided by 2 (on the stretch of the easel used according to the roof plan plan 10.50 meters divided by 2),* input the *angle or height of the easel select one if* input The angle then the height automatically changes to adjust the angle.

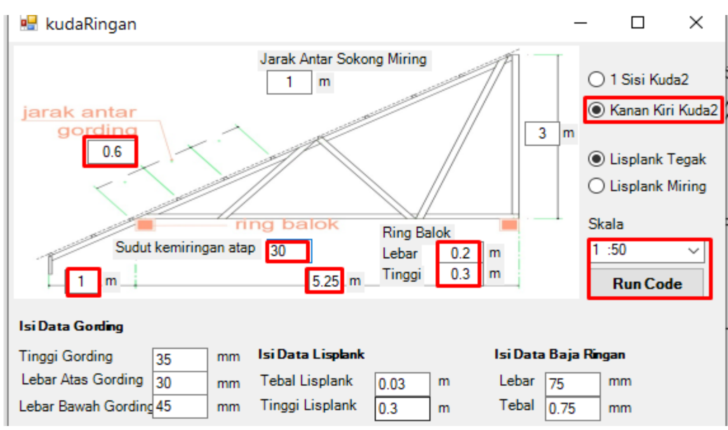


Figure 4.7 Use of automation *features detailed easel*

In *mild steel input data can be changed if the size of mild steel adjusts the specifications and type* of mild steel used, input *data for mild steel in millimeters, adjust to the information on the label of the unit of measure used*.

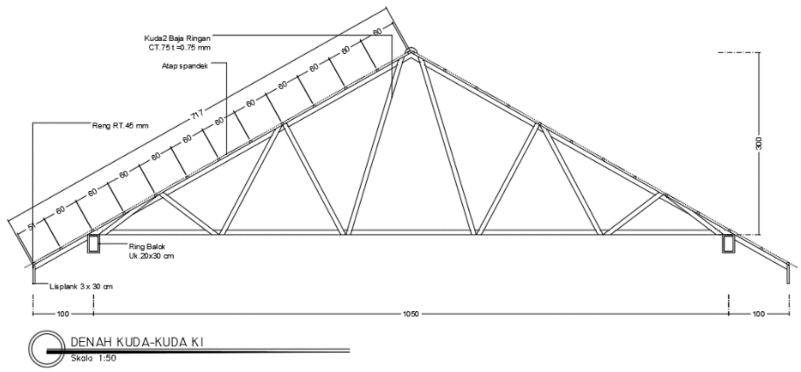


Figure 4.8 Results of using automation *of the easel detail feature*

Discussion Automation *features detail light steel horses*

The use of automation *features of mild steel easel* is very helpful in drawing because only with *data input in* the input *form* then the image is made automatically, if using *automatic command* (AC) methods it will take a lot of time because there are many items that must be done such as dividing the number of *curtains* With the same distance, making a support frame for the easel and so on, automation *of features* if the user *when* inputting *data using text on the supposed number will not be* able to be inputted *because the system for alphabets is not activated if the input nature* is a number. The time needed to automate the detailed depiction of light steel horses by 2 seconds is very fast and the time efficiency is very large when compared to drawing with the default AutoCAD® command (*automatic command*).

Portal slice details

To create a portal cut it should look at the floor plan on the symbol notation how much the cut does, and to see the height of the beam and sloof *should be seen at the* sloof plan plan and beam plan plan. In the figure below that will be created portal in notation *B* will be the same cut result with notation *D* for the width between columns seen in notation 1-6 and the thickness of the elevation of the *sloof* and beam can be seen in the plan plan of the sloof *and the plan of the beam (for each elevation of the beam), beams with the thickness of* the sloof 0.4 meters, pinch beam 2.5 elevation 0.13 meters thick, 1st floor beam 0.4 meters thick at 4 meter elevation, 0.13 meters thick pinch beam at 6.50 elevation and 0.3 meter thick beam ring at 7 meter elevation.

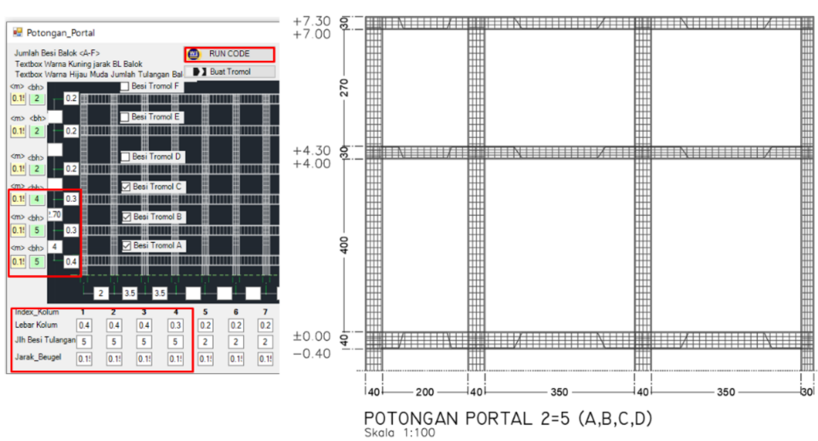


Figure 4.97 Results and use of the portal snippet feature *automation*

The time required to create *a portal chunk A=B (1-5) is 2 seconds, and the creation time of* a portal chunk 2=5 (A,B,C,D) *is 2 seconds the* total time is 4 seconds. The use of the portal *slice feature automation is very important and very useful in speeding up work time, because the nature of the image is very complex to be drawn manually in AutoCAD, with the portal image cut feature only input data then the image will be created automatically in AutoCAD®* ®, if using the *automatic command* (AC) work method which must be *offset* In the past, the distance between the begel, with the required size and size of the iron diameter and many built-in AutoCAD® commands used such as *copy*, rotate, *trim*, extend, *dimension* and so on by using automation *portal* cut feature some of the commands above are combined into one, *layer* creation For each type of type the line is created automatically. The program is also equipped with if *the input* data is empty, the program will tell *the user* there is data that cannot be empty. In the name of the typical *detail* creation command, everything is made in *the input form* because the *data input* is very complex and complicated and the *insert* method to AutoCAD® is all the same, only asking for the location *of the starting point (base point*) of the drawing to be *inserted*.

Depiction layout

With the *multiple* plot feature, it is very helpful to create *layouts* from *models* with one click, all images will be neatly arranged in the layout *and with one click the images will be saved and merged in one* pdf *file*. If using the *usual command* (UC) method you have to click one suitcase after another *and in Zoom* and so on too much time is needed for the default UC command *plot* in AutoCAD®.

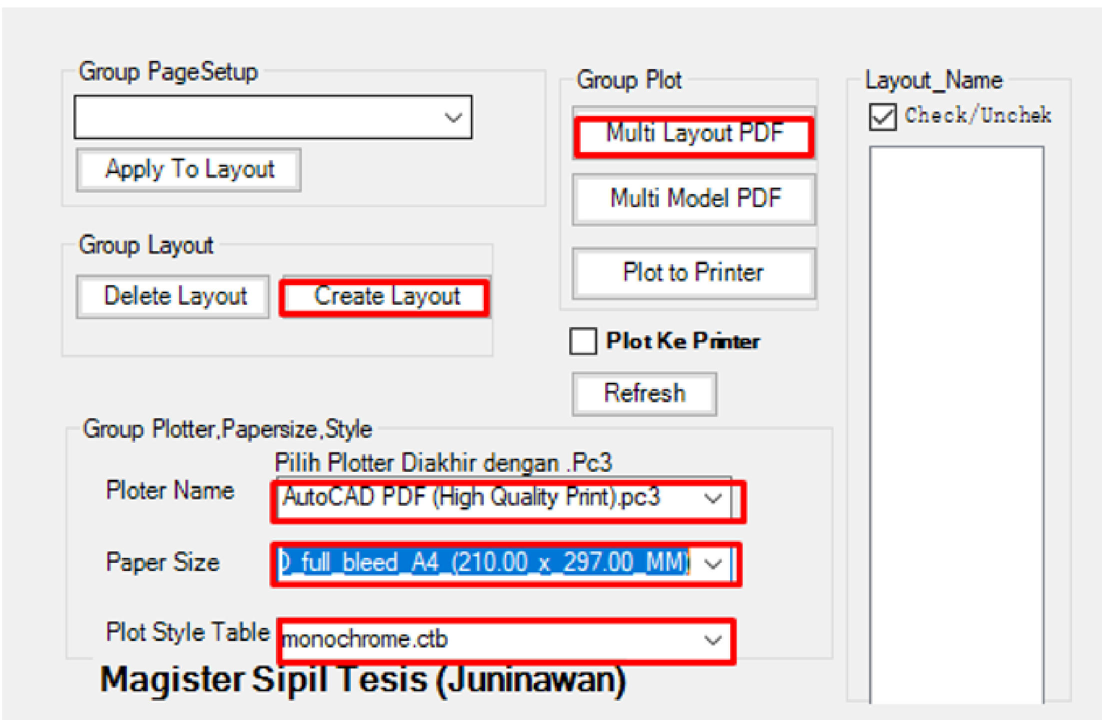


Figure 4.109 Use of multiple *plot feature automation*

Results of Time Efficiency and Accuracy

Time efficiency results

In table 4.2 below is the result of a recapitulation of the accumulated time calculation for each respondent, for testing the time of each respondent listed in *Appendix B.*

Table 4.1 UC and AC depiction time efficiency recap

Respondent Number	Time of *usual command*	Time of *automatic command*	Unit of Time
1	18493	531	Detik
2	18600	518	Detik
3	19576	533	Detik
4	19598	366	Detik
5	18300	528	Detik
6	16385	484	Detik
7	18000	715	Detik
8	18105	578	Detik
9	18634	744	Detik
10	19972	559	Detik

A. IBM SPSS application analysis results

For the requirements for the analysis of two paired samples, the data must be normal in Chapter III previously discussed the same test requirements and computer specifications, and the ability of respondents is also the same so that the data is normal, so there is no need to check whether the data is normal, to ensure whether the data is normal is also done with the SPSS application.

- Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Konvensional	.190	10	.200*	.919	10	.348
Automasi	.218	10	.195	.906	10	.256

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 4.11 Normality test results with SPSS

Results of normality test output analysis using *SPSS* application data *usual command* (*conventional*) *sig value*. = 0.348 if the significance value (*Sig.*) > 0.05 then the data is **normal** , otherwise if the value of *sig.* < 0.05, the data is abnormal, for the results of the significance value automation analysis (*SIG.*) = 0.256 > 0.05 then the data is normal. Then it can be continued to test t two samples in pairs (*Paired Samples t Test*).

- A close-up of a test Description automatically generated*paired samples t test*)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Konvensional - Automasi	18010.70000	1044.24902	330.22053	17263.68925	18757.71075	54.541	9	.000

Figure 4.12 Results of t-test analysis of two samples in pairs SPSS

Output analysis results of SPSS significance value (*sig.*) = 0.000 < 0.05 so there is a huge difference in time efficiency between drawing using *usual commands* (*conventional*) and automation in *AutoCAD®* software.

The results of the analysis use the value of t, the value of t-table (df = 9) = 2.261 while the value of t-count from *Figure 4.102* is 54.541, if t-calculate > t-table then there is a very large difference in time efficiency between drawing using *usual command (UC)* and automatic command *(AC) in* AutoCAD® *software*.

B. Excel application analysis results

- Using *Add in* Analysis ToolPak

t-Test: Paired Two Sample for Means

	Waktu Konvensio	*ktu Automasi*
Mean	18566,3	555,6
Variance	1048162,46	11753,6
Observations	10	10
Pearson Correlation	-0,1375747	
Hypothesized Mean Difference	0	
df	9	
t Stat	54,5414296	
P(T<=t) one-tail	5,8876E-13	
t Critical one-tail	1,83311293	
P(T<=t) two-tail	1,1775E-12	
t Critical two-tail	2,26215716	

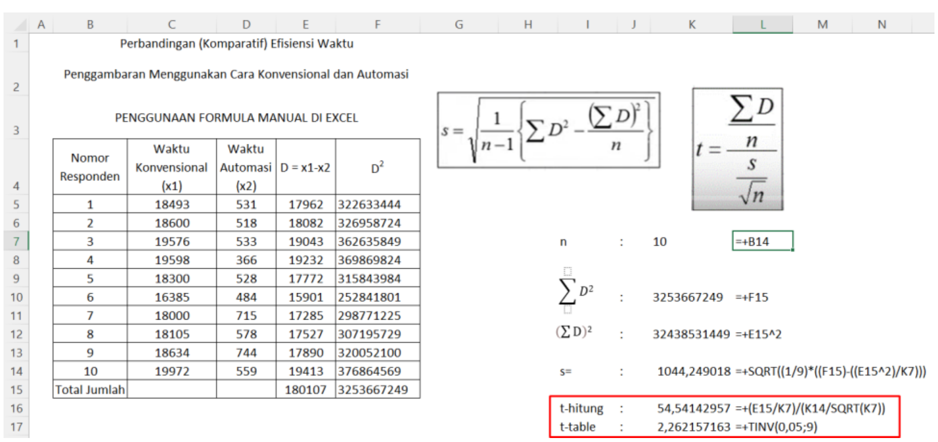
Figure 4.13 Analysis results using *Excel's* Add in Analysis ToolPak

The t-count value in figure 4.104 rounded 54.541 is the same as the t-calculated value using the SPSS application, while the t-table value other than using the statute table *(Table 3.4 The value of the r-table (SPSS Source Indonesia.Com*) can use the excel formula *TINV(Probability, Degree Freedom)* enter the *Probability* value 0.05 and the degree freedom (df) value is 9 (or the number of data-1) then the t-table value = 2.261, the t-count value is 54.541 > 2.261 then there is a big difference in time efficiency of drawing using the *usual command (*UC) method with *automatic command* (AC). Or by using the significance value *of Figure 4.104 Analysis Results Using the Add in Analysis ToolPak*, the sig value. = 1.1775E-12 (1.1775 x 10-12 or equal to 0.00000000000001775 rounded equals 0.00), *sig value.* 0.00 < 0.05 then there is a large difference in time efficiency depiction using the *usual command method* with *automatic command*.

- Using *Formula Ttest in Excel*

Find the significance value with excel formula *T.TEST(UC Data*, AC Data, *2, 1)* the result *of significance value equals* 0.00 significance result equals sig *value*. If using the SPSS application or using *the Excel Add in Analysis tool pack.*

- Use manual formulas in Excel


Perbandingan (Komparatif) Efisiensi Waktu

Penggambaran Menggunakan Cara Konvensional dan Automasi

PENGGUNAAN FORMULA MANUAL DI EXCEL

Nomor Responden	Waktu Konvensional (x1)	Waktu Automasi (x2)	D = x1-x2	D^2
1	18493	531	17962	322633444
2	18600	518	18082	326958724
3	19576	533	19043	362635849
4	19598	366	19232	369869824
5	18300	528	17772	315843984
6	16385	484	15901	252841801
7	18000	715	17285	298771225
8	18105	578	17527	307195729
9	18634	744	17890	320052100
10	19972	559	19413	376864569
Total Jumlah			180107	3253667249

$$s = \sqrt{\frac{1}{n-1}\left\{\sum D^2 - \frac{\left(\sum D\right)^2}{n}\right\}}$$

$$t = \frac{\frac{\sum D}{n}}{\frac{s}{\sqrt{n}}}$$

n : 10 =+B14

$\sum D^2$: 3253667249 =+F15

$(\Sigma D)^2$: 32438531449 =+E15^2

s= : 1044,249018 =+SQRT((1/9)*((F15)-((E15^2)/K7)))

t-hitung : 54,54142957 =+(E15/K7)/(K14/SQRT(K7))

t-table : 2,262157163 =+TINV(0,05;9)

Figure 4.14 Analysis of t value with Excel formula

In the picture above can be seen the value of t-count = 54.541429 the result is the same using the SPSS *application,* Add in Analysis toolPak Excel *and t-count value > t-table (54.541429 > 2.26157), from the comparison* *of several analysis methods above it can be concluded "there is a very large difference in time efficiency using* the usual command (UC) drawing *method with the* automatic command *(*AC) drawing method on *AutoCAD*® Software".

Accuracy test results

The results of testing the accuracy of the automation function of each respondent are attached to *Appendix B.* The conclusion of the results of testing the accuracy of all functions of automation is **100% valid accuracy**

4. Conclusion

There is a very large time difference using the way of drawing by means of automation because in general AutoCAD® commands are one command for the execution of one object and for one result, on the contrary with automation can be programmed for one command, for many objects and many results.

Automation of drawing building components can be made with one command (combining many commands in one command) to draw as a whole, because there are typical patterns such as detailed depiction of reinforced concrete, detailed depiction of continuous foundations, detailed depiction of local tread foundations, detailed depiction of easel, depiction of portal pieces and so on, data input methods generally use forms, and the insert method to AutoCAD® using the insert point of the base point of the detailed drawing.

Automation of the depiction of building components that cannot be customized with one command, examples such as making column plan plans, frame plan plans and so on because the building components are dynamic (the shape of the model is not always the same), so in its implementation there are several commands developed with automation, in making floor plans there are similar patterns, namely offset commands from the center line (as line) with distances to the right and left has the same value, and there is a common pattern there are trim and extend on the lines that are offset, with automation helping the offset work of objects at once along with trim and extend at once and there are other supporting commands such as making dimensions quickly with one selection, recapping object quantity tables and so on.

Recommendations for construction practitioners and subsequent research that the depiction of building components that are part of civil science, there are many patterns of similarity in repetition of depictions that continue to occur, for example the depiction of cross section roads, typical depictions of building components considering that it is necessary to automate the depiction but it needs to be a note that there are many types of program languages, if program automation with inappropriate languages causes the nature of automation difficult to be implemented by users, so sometimes the time efficiency between time efficiency between automation and the usual command (UC) method is not achieved in accordance with the objectives (not effectiveness) as a recommendation to use automation with the C # language which is rich in features, object calculation processing, interfaces, APIs and so on.

Recommendations for future research to further develop the use of NET AutoCAD-based® program automation because of the ease of implementing program automation because the features of objects in NET are very complete, other recommendations for future research so that typical building components are more complete types, for example for roof details there are many types of roof shape details.

And further research recommendations further explore the use of NET AutoCAD by connecting AutoCAD with several other applications such as Excel, Access and other applications that can be well integrated with AutoCAD®®®.

5. References

Autocad, A. (2023). *Autocad 2023 Developer And Objectarx Help | Overview Of The Autocad .Net Api (.Net) | Autodesk*. Autodesk. Https://Help.Autodesk.Com/View/Oarx/2023/Enu/?Guid=Guid-390a47db-77af-433a-994c-2afbbe9996ae

Aws, Amazon. (2014). *Apa Itu .Net? Penjelasan Tentang Dotnet - Aws*. Aws. Https://Aws.Amazon.Com/Id/What-Is/Net/?Fbclid=Iwar28qsi0g61chgjfr-Uxzh1nfidjkpikohjaozmwdakr0vjtzuigbmohpzu

Emzir. (2009). *Metodologi Penelitian Pendidikan Kualitatif & Kualitatif*. Rajawali Pers. Https://Library.Unismuh.Ac.Id/Opac/Detail-Opac?Id=2390

Gassel, F. Van, & Gassel, F. Van. (2005). The Development Of A Concept For A Dutch Construction System For High-Rise Buildings. *Isarc Proceedings*, 0–0. Https://Doi.Org/10.22260/Isarc2005/0042

Kartika, R. (2023). *Pengertian Dan Contoh Hardware, Software, Dan Brainware*. Kompas.Com. Https://Www.Kompas.Com/Skola/Read/2023/02/22/163000869/Pengertian-Dan-Contoh-Hardware-Software-Dan-Brainware?Page=All

Kocsis, B. (2009). *Aspect Oriented Data Management In Autodesk Autocad With Microsoft .Net*.

Kurnia, F. (2022). *Efisien: Pengertian, Contoh, Dan Perbedaanya Dengan Efektif*. Dailysocial. Https://Dailysocial.Id/Post/Efisien-Pengertian-Contoh-Dan-Perbedaanya-Dengan-Efektif

Masripah, S. (2019). Pengujian Black Box Pada Sistem Informasi Penerimaan Siswa Baru Berbasis Web. *Nformation System For Educators And Professionals*, *4*, 1–12.

Microsoft, V. S. (2023). *Apa Itu Visual Studio? | Microsoft Learn*. Microsoft.Com. Https://Learn.Microsoft.Com/Id-Id/Visualstudio/Get-Started/Visual-Studio-Ide?View=Vs-2022

Miswanto. (2010). *Diktat Analisis Vektor*. Iain Tulungagung.

Muhid M.Si, A. (2019). *Analisis Statistik 5 Langkah Praktis Analisis Statistik Dengan Spss For Windows - Dr. Abdul Muhid, M.Si - Google Books*. Zipatama Jawara. Https://Books.Google.Co.Id/Books?Hl=En&Lr=&Id=K3ideaaaqbaj&Oi=Fnd&Pg=Pa1&Dq=Spss+Cara+Komparasi+2+Pasangan&Ots=Nk9mned1uv&Sig=Xaifspm2jc8-I3hfy-Mfrpjhmi0&Redir_Esc=Y#V=Onepage&Q=Spss%20cara%20komparasi%202%20pasangan&F=False

Nazir, Moh. (2009). *Metode Penelitian* (R. Sikumbang, Ed.; Vol. 1). Ghalia Indonesia.

Raharjo, S. (2021). *Cara Uji Paired Sample T-Test Dan Interpretasi Dengan Spss - Spss Indonesia*. Spss Indonesia. Https://Www.Spssindonesia.Com/2016/08/Cara-Uji-Paired-Sample-T-Test-Dan.Html

Ross, A., & Willson, V. L. (Professor Of Educational Psychology). (2017). *Paired Samples T-Test* (1st Ed., Vol. 1). Brill. Https://Brill.Com/Display/Book/9789463510868/Bp000005.Xml

Sahid, Muh. N. (2017). *Teknik Pelaksanaan Konstruksi Bangunan - Ir. H. Nur Sahid, M.M., M.T. - Google Books*. Muhammadiyah University Press. Https://Books.Google.Co.Id/Books?Hl=En&Lr=&Id=A7vvdwaaqbaj&Oi=Fnd&Pg=Pr3&Dq=Buku+Manajemen+Konstruksi&Ots=Ajyrwtx9c7&Sig=Ovkc98q46yzdnkladc3e4zc73ii&Redir_Esc=Y#V=Onepage&Q=Buku%20manajemen%20konstruksi&F=False

Sugiyono, P. Dr. (2013). *Metode Penelitian Kuantitatif Kualitatif Dan R&D* (19th Ed., Vol. 1). Penerbit Alfabeta.

Suharsimi, A. (2012). *Prosedur Penelitian* (R. Cipta, Ed.; 1st Ed., Vol. 1). Rineka .

T.Sutojo Dkk. (2010). *Teori Dan Aplikasi Aljabar Linear Dan Matriks* (A. Offset, Ed.; 1st Ed., Vol. 1). Yogyakarta : Andi Offset.

Tysara, L. (2021). *7 Macam-Macam Metode Penelitian Kuantitatif Dan Penjelasannya*. Www.Liputan6.Com. Https://Www.Liputan6.Com/Hot/Read/4706956/7-Macam-Macam-Metode-Penelitian-Kuantitatif-Dan-Penjelasannya