Development of spreadsheet-based applications for analysis and design of reinforced concrete beam as a learning tool in the Departmet of Civil Engineering at Bali State Polytechnic

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Abstract. This study aims to develop spreadsheet-based applications for the analysis and design of reinforced concrete beam structures as a tool in learning courses in Reinforced Concrete Structures in the Bali State Polytechnic Civil Engineering Department. Reinforced concrete is still one of the most widely used construction materials and is applied in the construction world, especially in Indonesia, which belongs to a region with a high level of seismic risk. The process of calculating reinforcement of reinforced concrete structures involves quite a number of stages. In the practice of classroom learning it is not uncommon for students to miscalculate at one or more stages that lead to inaccurate design results. The results of field trials on the use of applications developed in this study provide significantly better average scores for students who use the application compared to students who do not use the application.

1. Introduction

One material that is widely used in civil engineering buildings is reinforced concrete. In order to achieve the expected competencies, the 2016 curriculum for both Civil Engineering Study Program and Construction Project Management Study Program has courses on Reinforced Concrete Structures, taken in the second year or in the fourth semester. This course is given a weighting of 3 credits and learns about the characteristics of concrete materials, analysis and design of reinforced concrete structural elements that emphasize bending (beam), flexural and normal (column), shear and torque elements and taking into account the ability to fulfill requirements service of the structure.

The process of analysis and cross-section design of reinforced concrete structures go through many stages by involving formulas that are relatively complex, which have the potential for errors if done manually. For this reason, the existence of applications for cross-section planning of reinforced concrete structures is needed. Some of the previous studies that have been carried out are related to the auxiliary application of cross-reinforced concrete structure design, among others by Mello et al (2013) designing web-based reinforced concrete structure reinforcement applications; Handoko et al (2017) designed an android-based application for calculating reinforced beam cross sections.

In contrast to previous studies, the application of reinforced concrete reinforcement design developed in this study is spreadsheet-based, and is devoted as a learning aid to courses in reinforced concrete structures.

2. Methods

In brief, the stages in carrying out this research can be described as in Figure 1.

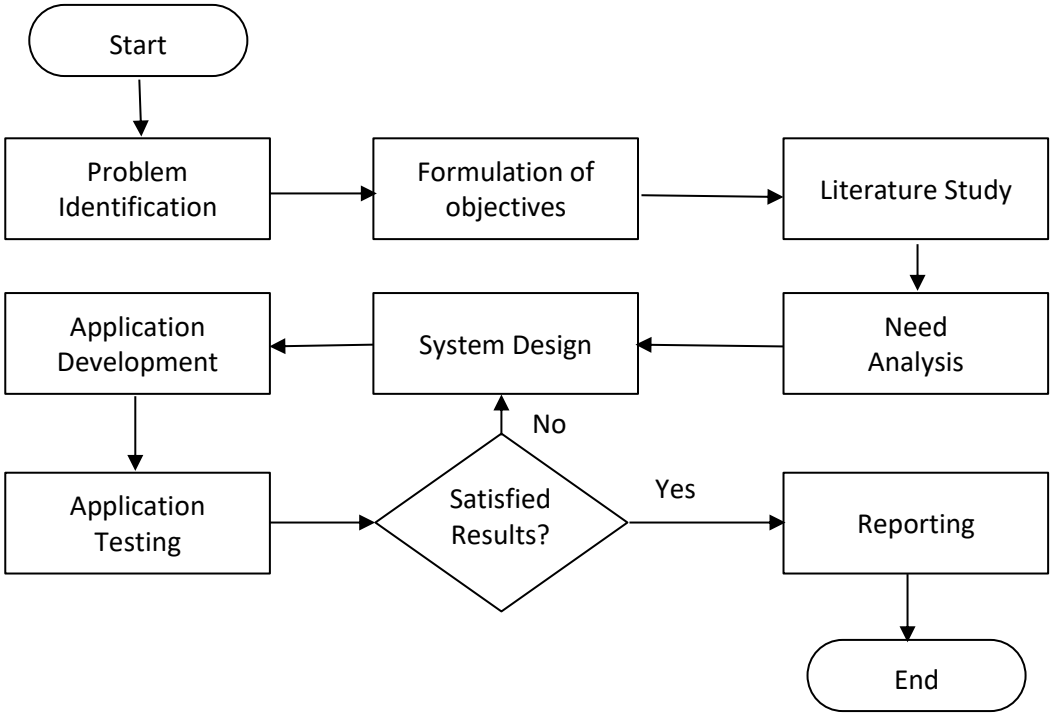

Figure 1. Stages of research.

2.1. Population and samples

The population of this study are all fourth semester students of Diploma IV in Construction Project Management, Civil Engineering Department, Bali State Polytechnic as many as four classes or 112 people.

Sampling in this study uses a cluster method with the following steps:

- From the fourth semester student population of four classes, two classes were randomly drawn.
- From each class selected in step 1, 20 people were randomly sampled as trial participants so that the total sample was 40 people.

2.2. Data analysis

Data obtained from the trial test will be analyzed with a different average formula.

- Different average formula

$$\overline{X}_1 - \overline{X}_2 = \Sigma Xi1 /n - \Sigma Xi2 /n \quad (1)$$

$\overline{X}_1$ is the average student achievement using the application and $\overline{X}_2$ is the average achievement of students who have not used the application developed in this study.

- Average difference test

Ho: $\mu 1 = \mu 2$

H1: $\mu 1 > \mu 2$

The statistical tests used are:

Ho : μ1= μ2

H1 : μ 1> μ2

Where μ is the mean of the variable under study.
The statistical tests used are:

$$t = (\overline{X}\,1 - \overline{X}\,2)/\sqrt{[\{(n1-1)s12+(n2-1)s22\}/\{n1+n2-2\}/\{1/n1+1/n2\}]} \quad (2)$$

where:

$$\overline{X} = (\Sigma Xi)/n$$

$$S = \sqrt{\{(X-\overline{X})2/n\}}$$

n = sample size
Accept Ho if t <= t (n1+n2-2,5%)
Reject Ho if t > t (n1+n2-2,5%)

3. Results and discussions

3.1. Application interface

	PERENCANAAN PENULANGAN BETON			
	A. DATA BESARAN STATIK			
	MOMEN MAKSIMUM [M]	(ton.m)	5.00	
	GAYA NORMAL [N]	(ton)		
	GAYA LINTANG [Q]	(ton)	5.00	
	B. DATA TEKNIS DAN METODA			
	JENIS KONSTRUKSI		BALOK	
	BENTUK PENAMPANG		PERSEGI	
	METODE PERHITUNGAN		KEKUATAN BATAS / ULTIMIT	
	TIPE PENULANGAN		TIDAK SIMETRIS	
	MUTU BETON		K-500	
	MUTU BAJA TULANGAN		U-32	
	JENIS PEMBEBANAN		BEBAN TETAP	
	C. DIMENSI PENAMPANG			
	TINGGI TOTAL ['ht' minimum 1/35 panjang bersih ℓo]	(cm)	30.00	
	LEBAR ['b' minimum 1/50 panjang besih ℓo]	(cm)	55.00	
	TANGGAL PERENCANAAN		1/7/2019	
	Copyright (2019): I Nyoman Suardika		KLIK...LANJUT...!!	
	Politeknik Negeri Bali			
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Figure 2. Application interface.

Figure 2 shows the interface of the application being developed. As input are data of cross section dimensions, concrete compressive stress at the age of 28 days, moments and shear forces acting on the beam. Figure 3 below shows the output of the application.

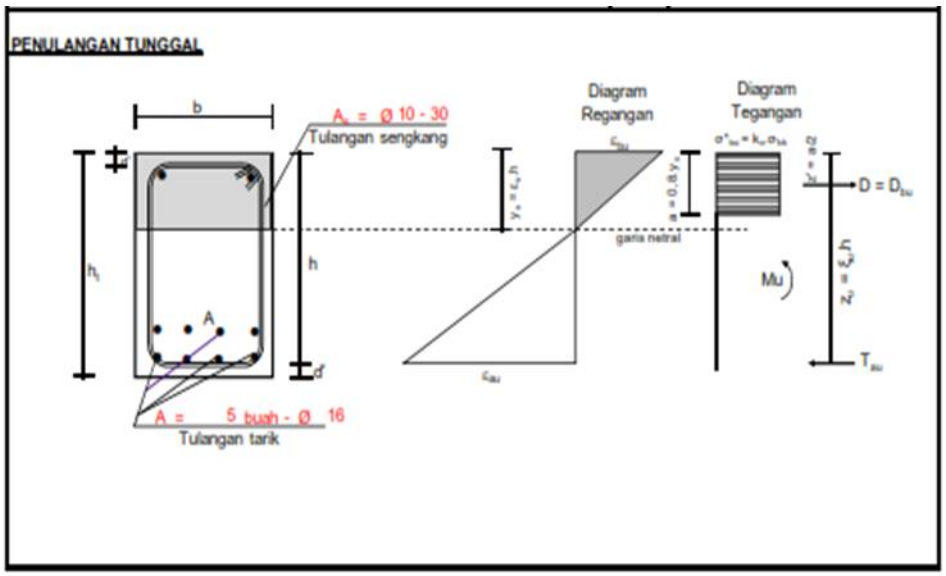

Figure 2. Application output.

3.2. Field trials

The population for field trials is all fourth semester students of the Project Management Study Program in the Department of Civil Engineering, Bali State Polytechnic, Academic Year 2018/2019, with four classes or 112 people. Sampling with cluster method, by randomly selecting two classes from four classes, then randomly drawn 20 people from each class selected so that the total sample is 40 people. The first group (Group A) was given a test to calculate reinforcement of reinforced concrete beams manually, while the second group (Group B) was given the same problem but using the help of an excel application module for calculating reinforced concrete beams developed in this study. The distribution of test results is shown in Table 1 and Table 2 below.

From Table 1 and Table 2, it can be calculated that the average value of Group B = 77.00, is greater than the average of Group A = 61.00 with each standard deviation are 13.99 and 18.04. The average difference test with Student's T-Test obtained the value of calculated t-value = 3.135 is greater than t-table value (1.663) with significance level of 5%. Thus H0 is rejected, meaning that the average value of the group using the excel application module for calculating reinforced concrete beams is significantly higher than the group not using the module.

Table 1. Distribution of test results for Group A.

Category	Range	Frequency	%
A	81-100	1	5.00
AB	76-80	2	10.00
B	66-75	6	30.00
BC	61-65	0	0.00
C	56-60	6	30.00
D	41-55	1	5.00
E	0-40	4	20.00
	Total	20	100.00

Table 2. Distribution of test results for Group B.

Category	Range	Frequency	%
A	81-100	5	25.00
AB	76-80	3	15.00
B	66-75	7	35.00
BC	61-65	2	10.00
C	56-60	3	15.00
D	41-55	0	0.00
E	0-40	0	0.00
	Total	20	100.00

4. Conclusion

Based on the results of the discussion above it can be concluded that the use of a spreadsheet-based application developed in this study provides a significantly better average score for students who use the application compared to students who do not use the application.

5. Suggestion

The application developed in this study is still limited to the reinforcement calculation on reinforced concrete beams, for the future it is necessary to develop other modules such as reinforcement calculation on reinforced concrete columns.

6. References

[1] Al Fatta and Hanif 2007 *Analisis dan Perancangan Sistem Informasi* Yogyakarta: Andi
[2] Calder N 2010 *Spreadsheets In Education (eJSiE)* **3**
[3] Cormac M and Brown R 2008 *Design of Reinforced Concrete 8th edition* New Jersey: John Wiley & Sons
[4] Hassoun M N and Al-Manaseer A 2005 *Structural Concrete Theory and Design 3rd edition* New Jersey: John Wiley & Sons
[5] Handoko P et all. 2017 *Dinamika Rekayasa* **13** 2 pp. 69-80
[6] Intara I W 2017 *Prosiding Seminar International (IJCST)* pp. 280-284
[7] Intara I W 2018 *Jurnal Logic* **18** 2 pp.72-79
[8] Jogiyanto H M 2008 *Metodologi Penelitian Sistem Informasi* Yogyakarta: Andi
[9] Kadir A 2003 *Pengenalan Sistem Informasi* Yogyakarta: Andi
[10] Mello G N A et all. 2013 *Proceeding International Conference on Engineering Education and Research* pp. 314-322
[11] Munawar 2005 *Pemodelan Visual dengan UML* Yogyakarta: Graha Ilmu
[12] McLeod R dan Schell G 2004 *Sistem Informasi Manajemen* Jakarta: PT. Indeks
[13] Nugroho A 2004 *Konsep Pengembangan Basis Data* Bandung: Informatika.
[14] Parker S P 1987 *Understanding Computers and Data Processing: Today and Tomorrow* New York: CBS College Publishing
[15] Politeknik Negeri Bali 2013 *Pedoman Pendidikan* Badung: Politeknik Negeri Bali
[16] Sutardi 2010 *Prosiding Pertemuan Ilmiah XXIV HFI Jateng & DIY* pp. 168-179