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CERTIFICATE

This is to certify that
Retno Tri Nalarsih

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Prof. Dr. Ir. Bambang Sugiarto, M.Eng.



QiR 2011 Chairman

Prof. Dr. Ir. Bondan T. Sofyan, M.Si.

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WELCOME FROM THE QIR 2011 ORGANIZING COMMITTEE

On behalf of the Organizing Committee, it is my greatest pleasure to extend our warmest welcome to all of you to the 12th International Conference on QIR (Quality in Research) 2011. The selected theme for this year's conference is "Integrated Design in Urban Eco-Technology for Quality of Life and Humanity". With this theme, the conference focuses on the scientific analysis and design of the key factors explaining the success applications of integrated design in urban eco-technology, their market perspectives, and their contributions to the existing and future development of humanity. In line with this theme, it is our utmost pleasure to hold the QIR 2011 in conjunction with the 2nd International Conference on Saving Energy in Refrigeration and Air Conditioning (ICSERA 2011).



With its continuous presence for 12 years, QIR has become an icon for Faculty of Engineering Universitas Indonesia in serving the objectives to provide engineering excellence for both national and international in all aspects of engineering, design, and architecture. For the first time, the QIR 2011 is held in a famous beautiful island of Indonesia - Bali. The QIR 2011 is supported by Universitas Udayana, in the spirit of strengthening of cooperation and mutual growth to be world class institution. I am delighted to inform you that we have such a large number of participants today, as indicated, that we will have 21 invited speaker presentation and more than 520 papers from more than 20 countries to be presented and discussed during these two days-conference. We are fortunate to have a lot of good quality papers belong to:

- 32 papers on ICSERA
- 39 papers on Chemical Engineering
- 115 papers on Electrical Engineering
- 37 papers on Mechanical and Naval Architecture Engineering
- 101 papers on Materials Engineering
- 54 papers on Architecture & Planning
- 75 papers on Industrial Engineering
- 72 papers on Civil Engineering

I would like to thank all contributors, speakers and participants for your generous support to this conference. It is my pleasant duty to thank all the members of Organizing Committee and the International Board of Reviewers for their advices and help. We are grateful to all Sponsors, Supporters, Exhibitors, Partner Universities and Professional Associations, for their spontaneous response and encouragement through committing funds and extending help in kind. I would like to sincerely thank the Rector of Universitas Indonesia and the Dean of Faculty of Engineering, for fully supporting the Committee and providing all supports to make this conference happen and to make it a success.

I wish you a very pleasant stay here in Bali; and finally, let me wish all of you a meaningful and fruitful conference. Thank you and we hope to see you again at the QIR 2013.

Prof. Dr. Ir. Bondan T. Sofyan, M.Si.
Chairman of QIR 2011 Organizing Committee

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Design of Coal Wastes Processing Unit And Their Utilization as Cement Replacement on Manufacturing of Building Materials To Control the Environmental Pollution

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ABSTRACT

Coal waste in solid waste from industry causing a negative impact, because of SO_x and NO_x compounds in the form of gas into the air and react with water vapor to form H₂SO₄ and HNO₃, resulting acid rain harmful to the environment and health problems. The purpose of this study is to utilize waste coal becomes fly ash and bottom ash where the fly ash is used as an alternative material in the manufacture of cementitious concrete block and cementitious concrete brick to have the better physical and mechanical properties and the higher value. Experimental method is applied to produce samples at the factory. Independent variables used in this study were: the composition of fly ash (20% and 40%); composition of sand: cement (8:0.75 and 10:1), time of mixture (4 minutes and 8 minutes). The dependent variable used is the compressive strength and porosity of the concrete blocks and concrete bricks. Data from testing the compressive strength and porosity were analyzed by Taguchi method to obtain the most optimum composition. The result showed that the composition of fly ash, the composition of sand: cement; and stirring contribution to contribute to the compressive strength of concrete blocks, each for 38.969%, 20.336% and 73.61%. While the percent contribution of the compressive strength of concrete blocks, each for 49.976%, 7.861%, and 15.169%. Percent contribution of each variable on the porosity of concrete block is 33.379%, 14.76% and 23.275%. While the concrete brick porosity of 35.567%, 94.47% and 9.04%. Output in this study is the composition of material for concrete blocks and concrete bricks containing coal waste (fly ash). It is found that in order to obtain concrete block and concrete brick quality in terms of compressive strength and porosity, it can be done by varying the composition of 20% fly ash, sand composition: cement 8:0.75 and stirring time of 4 minutes.

Keywords

Fly ash, compressive strength, porosity, concrete blocks, concrete bricks, Taguchi

1. INTRODUCTION

Coal including non-renewable energy sources, but the results showed that the coal reserves in the world today are still very abundant. Commencing in 1990, total world coal reserves estimated at 1079 billion tons and still reliable as a source of world energy by more than 230 years old, even expected to reach up to 300 years. In Indonesia alone, according to data on the PT. Bukit Asam Coal Mine, until 1991 the number of newly mined coal amounted to 14,478 thousand tones, out of total reserves are estimated at 34 billion tons. During this utilization of fossil fuels, especially coal, are very bad when associated with environmental pollution problems. Both SO_x and NO_x gases produced can react with water vapor in the air to form H₂SO₄ (sulfuric acid) and HNO₃ (nitric acid). Both can fall together rainwater resulting in acid rain which causes environmental damage and health problems.

Allegations that the waste disposal plant in Tempukrejo, Mojorejo Village, District Bendosari is waste coal, which is B3 solid waste (hazardous and toxic materials) has been proven. According to the Environment Office of Sukoharjo, in Government Regulation No. 85/1999 concerning Amendment to Government Regulation No. 18/1999 that Waste Management has clearly stated B3 included in category B3. In fact, all activities related to waste handling B3 must have permission from the authorities. Therefore, it is expected the industry immediately relocate the solid waste before the Ministry of Environment conduct annual checks on performance and feasibility of the industry. Waste coal turned out to be used as a mixture of raw materials or even alternative materials to replace cement. Utilization of coal waste as non-structural building materials such as concrete bricks, concrete blocks, or concrete brick press and also as a partial substitution of cement in the manufacture of concrete has been done by industry [1].

2. MATERIALS AND METHOD

2.1 Materials

Sample blocks and concrete blocks made by varying the composition fly ash (20% and 40%); sand: cement (8:0.75 and 10:1) and stirring (4 minutes and 8 minutes). Sample testing of compressive strength and porosity taken as many as 8 samples each of 3 times the replication. The reason for the use of as many as 8 samples based on orthogonal arrays are used that have been tested for normality of the data. Thus the total sample used by as many as 24 samples to test the compressive strength of concrete blocks, 24 samples to test the compressive strength of concrete bricks. As for the porosity test concrete bricks and concrete blocks of each 24 samples. Samples produced of this research are concrete bricks and concrete blocks made of high quality fly ash from the recycled waste coal. The quality of concrete blocks and concrete bricks are evaluated from the high compressive strength and low porosity.

2.2 Experiment Method

2.2.1 Sample production

With the increasing volume of waste coal, this would be a great environmental problem. Based on field observations, the spread of coal waste in the industry could be reclaimed for the future. In line with developments in the town of Sukoharjo development, the needs of particular buildings and concrete brick concrete block is also increasing. Based on observation, the soil around the Sukoharjo very suitable for building materials. Another problem that arises, for concrete brick and concrete block is the high price of Portland Cement (PC). Meanwhile, coal waste discarded by industry in the surrounding areas have the potential used for building material mixture of concrete brick and concrete block. Because of the high price of PCs and the availability of coal waste in large amounts motivating to find alternative low-cost cement replacement material. According to Dharmawan [2], utilization of coal waste in this form of fly ash can be used to make building materials. With a mixture of coal ash which is a waste power plant, was successfully created in a simple building block. The results showed that the concrete blocks of coal ash waste coal (TABB) with a ratio of 60: 40 (68.98 kg/cm²) but higher than the tela stone (50.45 kg/cm²). According to Priyatama [3], gain technical / economical obtained in the use of Fly Ash, among others:

- a. Improving the quality of building materials are stronger, more resistant to acid and lighter than the building materials of cement
- b. Increased efficiency of production cost of building materials
- c. Have major differences with other building materials due to cement replacement.

Efforts to control acid deposition is to use fuels containing less contaminants, avoiding the formation of pollutants during combustion, capture pollutants from exhaust gases and saving energy. Environmental pollution control can be done in several ways, among others:

- a. Use of Fuel With Low Sulfur content
- b. Reducing the sulfur content prior to combustion
- c. Control of Pollution During Combustion
- d. Control After Burning

2.2.2 Compressive strength test

Testing strength is one of many tests to determine the quality of the material. In this research, conducted tests on building materials made from waste coal is the compressive strength tests conducted by creating a standard specimen block and concrete brick concrete. Given load on the specimen until the crack / rupture. The amount of compressive strength is formulated as follows:

$$\text{Compressive strength} = \text{Load/Surface Area Kg/cm}^2 \quad (1)$$

Loading rate is 30 gr/cm²/second for wet specimens, and 150 gr/cm²/second for dry specimens. Compressive strength is not enough will cause the already outbreak of mold, while the compressive strength will prevent excessive depreciation of castings and cause cracks and difficult for demoulding [4].

2.2.3 Porosity test

Physical test used to determine the quality of building materials is the porosity test. Porosity is defined as the ratio of pore volume (i.e. the volume occupied by the fluid) of the total volume of building materials. There are two types of porosity that is inter-grain porosity and fracture porosity. Mathematically porosity can be written as follows:

$$\text{Porosity} = (\text{Voids volume} / \text{mixture volume}) \times 100\% \quad (2)$$

It should be noted, that the porosity in a test system vary widely. In naturally fractured reservoir system, the porosity ranges from slightly greater than zero, but can be worth is equal to one (1) on the voids. In general, the average porosity of a porous media system cost between 50-30%. So if the resulting value of porosity is less than 30% mean porosity is still small relative or are still considered safe.

2.2.4 Stages of Taguchi method

The stages to apply Taguchi method are as follow:

- 1) Selection and Adjustment Orthogonal Array (OA)
- 2) Taguchi Experimental Design
- 3) Brainstorming
- 4) Cause and Effect Diagram (Ishikawa Diagram)
- 5) Separating the control factors and noise factors
- 6) Determining the level of factor and value factor
- 7) Identify factors that may interact.
- 8) Describing the required linear graph for the control factors and interactions.
- 9) Choosing Orthogonal Array
- 10) Enter and / or interaction of factors into the column
- 11) Experimenting
- 12) Analysis of experimental results
- 13) Selection of optimal factor levels for the conditions.
- 14) Estimated average process at optimum conditions

3. RESULTS AND DISCUSSION

3.1 Compressive strength test results

Tests conducted on the compressive strength of materials laboratory, Department of Civil Engineering UNS Surakarta with experimental methods. Compressive strength testing is done as much as 8 times the experiment, each replicated 3 times, bringing the total sample data to test the compressive strength of concrete blocks and concrete blocks each of 24 samples. The purpose of this test is to find the optimal value of the compressive strength of concrete block and concrete products block in order to improve the quality and quantity of the product so that it can win market share [5]. Table 1 and Table 2 show the combination of mixture compositions and the results of testing the compressive strength of concrete brick and concrete block, respectively.

Table 1. Results of testing the compressive strength of concrete brick

Sample	FAKTOR							Compressive Strength (KN)		
	A	B	AXB	C	AXC	e	e	n1	n2	n3
1	1	1	1	1	1	e	e	190	240	210
2	1	1	1	2	2	e	e	190	190	210
3	1	2	2	1	2	e	e	210	230	190
4	1	2	2	2	1	e	e	230	210	200
5	2	1	2	2	1	e	e	240	195	210
6	2	1	2	1	2	e	e	100	160	120
7	2	2	1	2	2	e	e	120	120	160
8	2	2	1	1	1	e	e	90	80	90

Table 2. Compressive strength of concrete block

Sample	FAKTOR							Compressive Strength (KN)		
	A	B	AXB	C	AXC	e	e	n1	n2	n3
1	1	1	1	1	1	e	e	130	115	100
2	1	1	1	2	2	e	e	140	150	130
3	1	2	2	1	2	e	e	180	150	200
4	1	2	2	2	1	e	e	230	220	210
5	2	1	2	2	1	e	e	215	210	200
6	2	1	2	1	2	e	e	210	220	210
7	2	2	1	2	2	e	e	190	225	195
8	2	2	1	1	1	e	e	195	240	190

3.2 Porosity test result

Tests conducted in laboratory material porosity, Department of Civil Engineering UNS Surakarta. Porosity testing is done as much as 8 times the experiment, each replicated 3 times, bringing the total sample data to test the compressive strength of concrete blocks and concrete blocks each of 24 samples. The purpose of this test is to determine the optimal porosity value of concrete bricks and concrete blocks produced from fly ash in order to improve product quality so as to win market share. Table 3 and Table 4 show the combination of mixture compositions and the results of porosity testing of concrete brick and concrete block, respectively.

Table 3. Porosity test results of concrete bricks

Eks	FAKTOR							Porositas (%)		
	A	B	AXB	C	AXC	e	e	n1	n2	n3
1	1	1	1	1	1	e	e	40	35	23
2	1	1	1	2	2	e	e	21	53	30
3	1	2	2	1	2	e	e	17	29	35
4	1	2	2	2	1	e	e	32	28	36
5	2	1	2	2	1	e	e	18	38	26
6	2	1	2	1	2	e	e	41	16	22
7	2	2	1	2	2	e	e	17	24	43
8	2	2	1	1	1	e	e	20	28	38

Table 4. Porosity test results of concrete blocks

Eks	FAKTOR							Porositas (%)		
	A	B	AXB	C	AXC	e	e	n1	n2	n3
1	1	1	1	1	1	e	e	58	28	51
2	1	1	1	2	2	e	e	48	25	29
3	1	2	2	1	2	e	e	50	38	55
4	1	2	2	2	1	e	e	20	51	23
5	2	1	2	2	1	e	e	42	28	46
6	2	1	2	1	2	e	e	38	43	26
7	2	2	1	2	2	e	e	20	36	28
8	2	2	1	1	1	e	e	18	34	31

3.3 Discussion Using Taguchi Method

3.3.1 ANOVA response of concrete block's compressive strength

To know the main factors and interaction between the two main factors which significantly influence the compressive strength of concrete blocks response variables we used analysis of variance (ANOVA). Data used in ANOVA analysis has been transformed into a ratio S / N (signal to noise) [6]. The factors tested that significantly influence the compressive strength of concrete blocks with ANOVA is the composition of fly ash (20% and 40%); composition of sand: cement (8:0.75 and 10:1)

and stirring (4 minutes and 8 minutes), interactions composition of fly ash with a composition of sand: cement (AxB), the interaction of fly ash composition with stirring (AXC) which can be modeled as formula 3.

$$Y_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + \alpha\beta_{ij} + \alpha\gamma_{ik} + \varepsilon_{ijkl} \quad (3)$$

Where:

Y_{ijkl} = compressive strength of concrete blocks on the level of factor A - i, factor B j-th stage, C factor k th stage, interaction and interaction AxB AxC.

μ = overall average

α_i = effect of factor A level i-th

β_j = effect of factor B level j-th

γ_k = effect of factor C level of the k-th

$\alpha\beta_{ij}$ = effect of interaction AxB factor

$\alpha\gamma_{ik}$ = interaction effect of factors AxC

ε_{ijkl} = Error \sim II DN $(0, \sigma^2)$

Testing hypotheses and conclusions can be drawn from ANOVA table above are as follows:

i. $H_0: \alpha_1 = \dots = \alpha_3 = 0$ (no effect of fly ash composition factor),

H_1 : at least one pair of which is not the same. α

Conclusion: P Value = 49.97% > 5%, then reject H_0 , i.e. no effect of different levels of composition of fly ash on compressive strength of concrete blocks.

ii. $H_0: \beta_1 = \dots = \beta_3 = 0$ (no effect of the composition of sand, cement).

H_1 : at least one pair of β_i which is not the same

Conclusion: P Value = 7.861% > 5%, then reject H_0 , i.e. there are significant differences in levels of the composition of sand: cement on the compressive strength of concrete blocks.

iii. $H_0: \gamma_1 = \dots = \gamma_3 = 0$ (no stirring effect).

H_1 : at least one pair k that is not the same. γ

Conclusion: P Value = 15.169% > 5%, then reject H_0 , i.e. there are significant differences in levels of agitation on the response variable compressive strength of concrete blocks.

iv. $H_0: \alpha\beta_{11} = \dots = \alpha\beta_{33} = 0$ (no interaction effect of fly ash composition and the composition of sand: cement)

H_1 : at least one pair of $\alpha\beta_{ij}$ is not the same.

Conclusion: P Value = 11.171% > 5%, then reject H_0 , i.e. no interaction effect of different levels of fly ash composition and the composition of sand: cement on the compressive strength of concrete blocks

v. $H_0: \alpha\gamma_{11} = \dots = \alpha\gamma_{33} = 0$ (no interaction effect of fly ash and stirring)

H_1 : at least one pair of $\alpha\gamma_{ik}$ is not the same

Conclusion: P Value = 12.213% > 5%, then reject H_0 , i.e. no interaction effect of different levels of fly ash and stirring on the response variable compressive strength of concrete block

3.3.2 Main Effect

Average effects of main factors and interaction factors on compressive strength of concrete blocks with larger is better quality characteristic is the difference between level 1 to level 2 of each main factor and interaction. Main Effect biggest factor achieved in the composition of fly ash (A) for 4.023, while the smallest effect achieved between the composition of fly ash and mixing (AXC).

3.3.3 Optimum Conditions Press Strength Concrete blocks

The optimum condition is useful to know the level of each factor so that the response of the compressive strength of concrete blocks can be optimized. Factor-factors that influence the response of the compressive strength of concrete blocks in the main experiments is the composition of fly ash (A), the composition of sand: cement (B), stirring (C), the interaction of fly ash composition with the composition of sand: cement (AxB), the interaction of fly ash composition with stirring (AXC). The optimum conditions selected for each level which gives an average value of S / N ratio is highest. The optimum conditions for the compressive strength of concrete block achieved at A1B1C1 conditions, meaning that in order to optimize the compressive strength of concrete blocks required parameter settings, meaning that 20% fly ash composition, the composition of sand: cement 8; 0.75 and stirring 4 minutes.

3.3.4 Transformation of the Power of Optimum Conditions of concrete bricks

The amount of S / N ratio of the optimum based on the variation of fly ash composition, the composition of sand: cement and mixing and interaction between the two factors that can optimize the compressive strength of concrete blocks with a characteristic quality of Larger is Better at 50.219 with MSD value of 0.00001.

3.3.5 Confidence Interval on Compressive strength of Concrete bricks

In optimizing the compressive strength of concrete blocks used for the 90% confidence level and Confidence Interval + / - 0761, then it can obtain the optimum value of 50 219 + / - 0761 or 49 458; 50.98 which is expected to be used as a reference in the manufacture of high quality building block in terms of compressive strength.

3.3.6 Distribution Variations on Compressive strength of concrete bricks

Based on the graph in Figure 2 shows that, in order to optimize the optimum compressive strength of concrete blocks, the compressive strength of 174.375 with S / N Ratio of 44.291. In the improved condition, the value of S / N ratio increased to 50.219. Cp and Cpk values in the initial conditions of 1. This value increased to 1.978 in the improved condition, which means making concrete bricks which have optimum compressive strength can be done by combining the three variables, namely the composition of fly ash, the composition of sand: cement and mixing. This is indicated by the value of Cp > 1, so that the resulting blocks have high strength. LSL value achieved by 19,667, while the value of USL at 329,082. The value of loss function which can optimize the optimum compressive strength of concrete blocks at 74.4 cents / \$ 1 Loss.

Using the same procedure, Taguchi method was applied to find the optimum composition of mixture for optimum compressive strength of concrete block, minimum porosities of concrete blocks and concrete brick. The resume of the results are as follow:

Combination Fly ash composition (A), the composition of sand: cement (B), stirring (C), interaction between the composition of fly ash with a composition of sand: cement (AXB) and fly ash composition interaction with stirring (AXC) contributed to the compressive strength of concrete blocks, each for 49.976%, 7.861%, 15.169%, 11.171% and 12.213%. Combination Fly ash composition (A), the composition of sand: cement (B), stirring (C), interaction between the composition of fly ash with a composition of sand: cement (AXB) and fly ash composition interaction with stirring (AXC) contributed to the compressive strength of concrete blocks, each for 38.969%, 20.336%, 7.361%, 27.997% and 5.096%. Combination Fly ash composition (A), the composition of sand: cement (B), stirring (C), interaction between the composition of fly ash with a composition of sand: cement (AXB) and fly ash composition interaction with stirring (AXC) contribute to the porosity of concrete bricks, each for 3.567%, 9.447%, 9.04%, 31.68% and 12.804%. Combination Fly ash composition (A), the composition of sand: cement (B), stirring (C), interaction between the composition of fly ash with a composition of sand: cement (AXB) and fly ash composition interaction with stirring (AXC) gave donations contribute to the porosity of concrete blocks, each for 33.379%, 14.76%, 23.275%, 13.044% and 13.073%. Level of factors that can optimize the compressive strength of concrete brick is A1B1C1, meaning the composition of 20% fly ash, sand composition: cement 8:0.75 and stirring 4 minutes. In the compressive strength of concrete blocks is A2B2C2, meaning the composition of 40% fly ash, sand composition: cement mixing 10:1 and 8 minutes. The optimization is achieved at the level of porosity concrete brick A2B2C1, meaning that 40% fly ash composition, the composition of sand: cement mixing 10:1 and 4 minutes, Meanwhile the optimal factor levels at the same porosity of concrete blocks with compressive strength of concrete blocks is A2B2C2. Cp and Cpk values on the compressive strength of concrete blocks, concrete blocks, concrete bricks and concrete blocks porosity in the initial conditions of 1. This value has increased in the improved condition each being the compressive strength of concrete blocks 1.978, 1.603 on the compressive strength of concrete blocks, 1.287 and 1.499 on the porosity of concrete bricks, concrete bricks and concrete blocks that are generated by combining three variables: Fly ash composition, the composition of sand: cement and agitation have a high capabilities evaluated from the high compressive strength and low porosity.

3.4 Optimization of Compressive Strength and Porosity Concrete blocks and concrete Block MRSN Method (Multiple Response Signal To Noise)

This procedure is an optimization procedure based on the selection of several alternatives. In this case is how to maximize the compressive strength of concrete blocks and concrete blocks at the same time minimizing the porosity of concrete bricks and concrete blocks simultaneously in order to obtain high-quality products along with increased selling prices.

Table 6. MRSN Value

Experiment	Factor							TNQL	MRSN
	A	B	AXB	C	AXC	BXC	e		
1	1	1	1	1	1	1	e	1,097	30.4027
2	1	1	1	2	2	2	e	964	29.8413
3	1	2	2	1	1	2	e	962	29.8314
4	1	2	2	2	2	1	e	782	28.9327
5	2	1	2	1	2	1	e	778	28.9080
6	2	1	2	2	1	2	e	714	28.5396
7	2	2	1	1	2	2	e	632	28.0055
8	2	2	1	2	1	1	e	615	27.8897

Results on Table 6 showed that application MRSN procedure to optimize the compressive strength and porosity of concrete blocks and concrete blocks simultaneously obtained A1B1C1 parameter variations. Therefore, in order to obtain concrete block and concrete products block quality in terms of compressive strength and porosity of the optimum, it can be done by varying the composition of 20% fly ash, sand composition: cement 8:0.75 and stirring time of 4 minutes.

IV. CONCLUSION

The main factors which significantly influence the quality of concrete bricks and concrete blocks in terms of compressive strength and porosity is Fly ash composition, the composition of sand: cement and mixing. The interaction factor is the interaction between fly ash composition and the composition of sand: cement, fly ash composition interaction and mixing .

The application MRSN procedure to optimize the compressive strength and porosity of concrete blocks and concrete blocks simultaneously obtained A1B1C1 parameter variations. Therefore, in order to obtain concrete block and concrete products block quality in terms of compressive strength and porosity of the optimum, it can be done by varying the composition of 20% fly ash, sand composition: cement 8:0.75 and stirring time of 4 minutes.

REFERENCES

- [1] Riyantiningsih, 2007, *Pemanfaatan limbah tekstil sebagai bahan bangunan Arena Tekstil* Vol. 21
- [2] Agus Dwi Darmawan, 2008, *Abu Penyerap Limbah*, Jurnal Sain dan Teknologi, Jakarta
- [3] Prijatama, 2006, *Keuntungan Teknis/Ekonomis dari Beton Keramik*, Pusat Penelitian Geoteknologi LIPI, Jakarta.
- [4] Suhardoko, Musabbikhah, 2007, *Rancang Bangun Mesin Pembuatn Bahan Bangunan Multi Fungsi Dengan Sistem Hidrolik*, laporan TTG, Diknas, Semarang
- [5] Nicolo Belavendram., 1999, *Quality By Design*, Second Edition, Prentice Hall, International.
- [6] Phillip J. Ross, 1998, *Taguchi Techniques for Quality Engineering*, Second Edition, MC Graw Hill, Singapore.