Defect Analysis of Building Construction Works Building in Surabaya with Six Sigma Method

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Abstract:- In the process of construction defect issue work hard to avoid even happens repeatedly, it causes swelling of the cost and time of implementation. In a previous study concluded that the cost of repairs due to defects employment of 4% of the value of construction contracts. The purpose of this study is to identify the types of defects based on the level of sigma and analyze variables and simulating the cause of defect repair recommendations for improving sigma level. In identifying and analyzing defects used six sigma method work through several stages of the Define, Measure, Analysis, Improve and Control. The results of this study showed 14 types of defect construction work, from some defect that there are two types of defects jobs require increased sigma level, because it is below the level of three sigma. The first defect type is a porous structure with concrete columns sigma level of 2.75 and a variable that has a high influence is less than perfect compaction when casting. The second type is the distance point defect piles not according to plan with sigma levels 2,86 and variables that most influence is the lack of communication with the consultant planner and owner. Based on the simulation recommendation defect corrective action on concrete columns porous structure, resulting in improved sigma level of 3.63 when the eighth recommendation implemented. At the distance of a point defect pile foundation is not according to plan, after the simulation of recommendations for improvement sigma level to 3.48.

Keywords:- *building construction work defects; six sigma level; quality function deployment; Monte Carlo simulation.*

I. BACKGROUND

Imperfections result of construction work is a problem which can reduce the quality of the work, it must be quickly resolved so that the quality of work as expected. All efforts made by the central government and the local governments by issuing several regulations in the field of construction, but still imperfections or defects in construction are still common.

In law no.2 in 2017 on construction services that the construction sector is building a community that serves as a consummate, or infrastructure support social and economic activities of society in order to support the realization of national development goals, as well as construction services must ensure order and legal certainty. Often construction projects suffered imperfections result of the work during construction or upon delivery of the implementation of the interim results of the work to the owner. In the process of construction work difficult jobs defect problems to be avoided even happens repeatedly, it causes swelling of the cost and time of execution (Sik Park et. Al, 2013).

Problems resulting from construction defects caused economic losses and can reduce the trust between the various stakeholders. In a previous study concluded that the cost of repairs due to defects employment of 4% of the value of construction. This research is about the kind of work the defects that occur in construction projects based on sigma level, so we know the quality of work kontrtuksi and simulate sigma level increase based on recommendations for improvement.

II. LITERATURE REVIEW

A. Construction defect

- Understanding the Construction Defect

In Black "s Law Dictionary (7th edition) defines" defect "which means" imperfections or deficiencies ". The term "imperfections" in ISO 9000: 2005 is a failure to meet a requirement. In the construction industry we often see the words' imperfections or deficiencies "in a job. In Indonesia itself has issued Government Regulation No. 29 of 2000 on the implementation of construction services in this Regulation defines the failure of the construction works is the state of the construction work that is not in accordance with the specification of work, as agreed in the contract construction work either in part or in whole as a result of user error services or service providers.

- Categories On the Construction Defect

Basically all forms of work are qualitative defect in which the judgment is based on quality pekerejaan generated, construction defect nature of the category itself is categorized into two, namely: a defect that is patent and the defect is latent (Barrett, 2008).

- *Defect Patent*

Patent defects are defects that looks directly to the eye and the degree of visibility that the lead role in analyzing the defect of a work (Barrett, 2008).

- *Latent defect*

Latent defect is a hidden defect and difficult job to be identified. Usually this kind of new defects identified after further investigation of the defect previously unknown work.

B. Construction Defect Causes

In the process of the construction work of the defect is difficult to avoid considering a construction project has a broad scope of work, which consists of several sub-units of work. The cause of the construction defect can be caused by one of the parties involved in the construction activities. For

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the realization of a building that gives satisfaction to consumers or users of the building, then the conditions that must achieve three things, among others: good workmanship during the construction process, materials or materials used in accordance with the requirements of good design and quality (Barrett, 2008). The root cause of the defect of construction generally determine the origin of the cause, and the defect factors, among others: Design, Work Processes, Materials and Maintenance (Chong et. Al 2006).

In another study said the main causes of construction defects are categorized into three types: design error, error workmanship and quality of materials used (Merhaba, 2015). By reviewing some of the references above about the cause of the defect of construction, should pay attention to several aspects including: Aspect Design, Process Aspects Construction, Materials Aspect, Aspect Maintenance.

- Design aspects

Design is a very important part in the development of projects to be undertaken padasuatu and affect the construction of a building, in other words the quality of a building is determined at the initial design (Ahzahar et. Al 2006).

- Aspects of the Construction Process

Construction work experiencing a job imperfections can be defined as work that does not meet the requirements of the agreed contract (Sabha, 2015).

- Material aspects

Selection of a material must meet the expected requirements, using poor quality materials will cause poor quality buildings. Selection of materials should be in accordance with the requirements of the specification in order to minimize the costs incurred during the maintenance phase (Hassanain et. Al, 2013).

- Aspect Maintenance

The success of a project depends on the performance, as measured by the cost of maintenance and the quality of workmanship standards, therefore the maintenance costs can be more expensive than the initial fee if the maintenance costs are not included during the planning stage (Femi, 2014).

III. RESEARCH METHODOLOGY

Quantitative research approach characterized by descriptive, where penedekatan is used as a theme or objects associated with the studies reviewed the state of empirical research sites. In the method of data collection used questionnaires, interviews and documentation obtained from the supervising consultant. In identifying and analyzing defects used six sigma method work through several stages Define, Measure, Analysis, Improve and Control.

IV. RESULTS AND DISCUSSION

A. Define phase

In this phase, the first stage in improving the quality, by defining and identifying the types of defects that occur in construction projects. In this study, which form the object of study consists of 15 construction projects, from the analysis identified 14 types of defects that construction work can be seen in the following table:

Defect Type Construction Work		Total Defect	Total Number of Jobs
A	Defect Foundation Work		
1	Distance point pile not according to plan	43	468 (group)
2	The depth of the foundation is not according to plan	8	468 (group)
3	Poles have cracks when lining	11	468 (group)
B	Defect At Work Concrete Columns		
4	Column formwork when casting the concrete structure uncovered	33	1200 (point)
5	Concrete columns porous structure after casting	126	1200 (point)
6	Concrete column is not symmetric	45	1200 (point)
7	The length distribution (continued) column reinforcement is less than the standard	39	1200 (point)
C	Defect At Work Concrete Beams		
8	Beam formwork when casting the concrete structure uncovered	52.8	10377.48 (m^1)
9	Porous concrete block structure after casting	196.7	10377.48 (m^1)
10	Deflection occurs on the beam	126.5	10377.48 (m^1)
11	The length distribution (connection) less than the standard beam reinforcement	156.75	10377.48 (m^1)
D	Defect At Work Concrete Beams		
12	Porous structure of the concrete slab after casting	84.25	11780.5 (m^2)
13	Deflection occurs at plate	35	11780.5 (m^2)
14	Having split the concrete slab	44	11780.5 (m^2)

Table 1. Type of construction work defects

B. Phase Measure

After pendifinisian issues to be analyzed, the next step is to measure the phase by measuring baseline measurement of performance and process capability.

1. Performance Measurement Baseline

In this study the performance baseline measurement is done by using parameters Defect Per Million (DPMO), and this value can be known DPMO sigma value of each type of defect construction work following calculation example:

- Distance point foundation in not according to plan

$$DPMO = \frac{43}{468} x1.000.000 = 91880{,}34 \quad (1)$$

Sigma value calculation:

From the above calculation obtained DPMO value of 91880.34, because the value is between 96800 (2.8 sigma level) and 80800 (2.9 sigma level) with respect to the conversion table sigma value, the sigma value calculation to be accurate to do by interpolation based on both values. To see the value of DPMO and sigma level of each defect type of construction works, can be seen in the following table:

Defect Type Construction Work		Sigma value	DPMO value
1	Distance point pile not according to plan	2,86	91880.34
2	The depth of the foundation is not according to plan	3.68	17094.02
3	Poles have cracks when lining	3.41	23304.27
4	Column formwork when casting the concrete structure uncovered	3.48	27500
5	Porous concrete column structure after casting	2.75	105000
6	Concrete column is not symmetric	3.22	37500
7	The length distribution (continued) column reinforcement is less than the standard	3.35	32500
8	Beam formwork when casting the concrete structure uncovered	4.04	5293.88
9	Porous concrete block structure after casting	3.54	19721.71
10	Deflection occurs on the beam	3.76	12683.26
11	The length distribution (connection) less than the standard beam reinforcement	3.75	15716.21
12	Porous concrete slab structure after casting	3.95	7151.65
13	Deflection occurs at plate	4.25	2971.01
14	Having split the concrete slab	4.12	3734.99

Table 2. Value of DPMO type of defect construction work

In the above table 2 can be seen the value of the lowest in the defect 5 sigma concrete columns porous structure after casting (sigma level 2.75) and followed defect pile 1 Distance point not according to plan. (2.86 sigma level). In a spread value DPMO facilitate viewing of each defect, then made the radar chart as shown below:

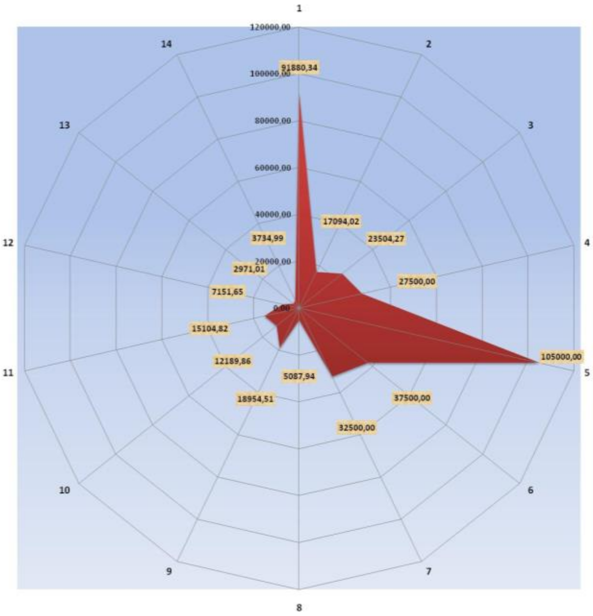

Fig 1:- Distribution of value DPMO type of defect

2. Measurement Process Capability

This measurement is taken on the type of defect is a defect analyzed the structure of porous concrete column 5 after casting (2.75 sigma level) and defect 1 Distance point pile is not as planned (2.86 sigma level). Since both types of defects are located below the industry average. In this study specification upper value limits (USL) is derived from the value of level 3 with defect specification 0.0667% and lower limits (LSL) is derived from the value of level 4 with defect 0.0062%.

- Measurement Capability defect porous structure of concrete columns

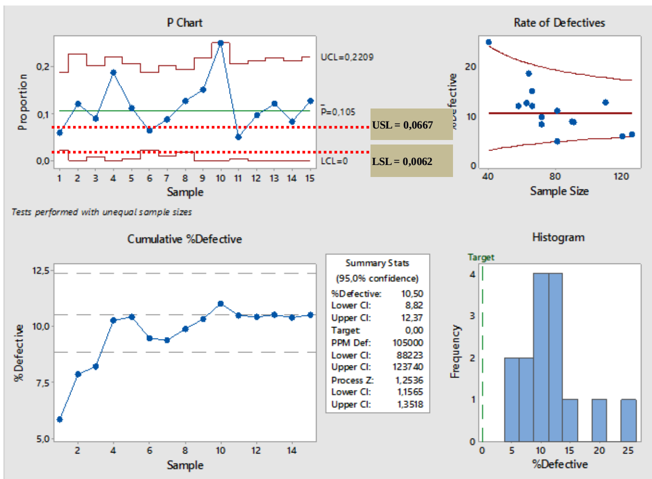

Fig 2:- Capability analysis binomial defect porous structure of concrete columns

- Measurement Capabilities within a point defect piles not according to plan

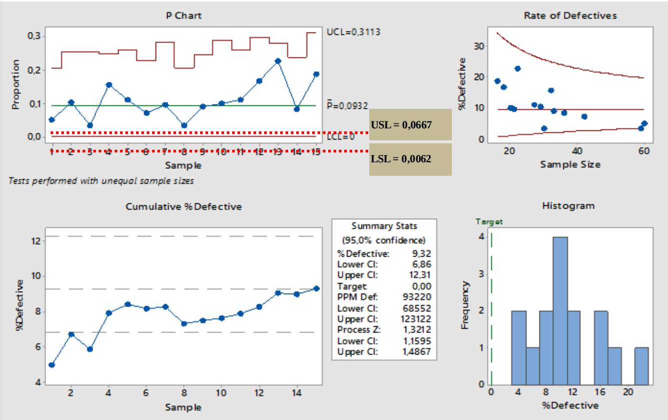

Fig 3:- Capability analysis binomial defect within a point of foundation

In the graph P chart we can see that from the 15 observation data is still at a value between UCL and LCL, the process is statistically under controlled conditions. But there are some points that came out of specification limits between LSL and USL.

On cumulative% defective chart is marked by instability along the line% defective average. Thus samples taken representative and reliable enough to describe the actual process Performance.

From the graph above the rate of defective can dililhat% randomly distributed around the center line, it can be concluded that the data follows a binomial distribution.

Histogram graph above shows that the existing process is not stable enough to produce a good product, because most of the stem the histogram is dikanan target value.

C. Phase Analysis

The purpose of this phase is to analyze the root causes that cause problems in the production process. Factors that cause the defect obtained from the collection of questionnaires by respondents team leader and chief inspector on the project. The results of this questionnaire using descriptive analysis that has been tested statistically, the following table analyzes the results of the causal factors:

- Factors causing defect porous structure of concrete columns

No.	Factors defect porous concrete column structure	mean	Std. dev	Rank
Q16	Compaction less than perfect when casting	4.133	0.8331	1
Q15	High-falling concrete at the time of casting	4.067	0.7981	2
Q14	Concrete cover on the column is too thin	4,000	0.845	3
Q9	The lack of experience of labor used	4,000	1.1338	4
Q17	Air cement out of the mold formwork	3,800	1.0141	5
Q4	Non-compliance and working procedures	3,800	1.0823	6
Q7	Lack of expertise implementers	3,733	0.9611	7
Q13	Usage column formwork more than 3 times the wear	3,667	1.1127	8
Q12	Too quickly dismantle the formwork	3,667	1.2344	9
Q10	Lack of teamwork	3,600	0.8280	10
Q3	Lack of commitment to quality assurance and quality control	3.533	0.9904	11
Q18	Pouring concrete material from the mixer too long Trux	3,333	0.8997	12
Q2	Ignore the request and instruction owner	3.133	0.9154	13
Q6	Lack komunakasi with planning consultant and owner	3.133	0.9154	14
Q1	Lack of periodic checks during the process of construction	3.133	1.1254	15
Q11	Use of equipment (vibrators) are not according to the standard procedure	3.133	1.1872	16
Q8	Too fast in execution to avoid delays	3.133	1.1872	17
Q5	The workers can not understand the working drawings	2,067	1.1629	18

Table 3. Mean and Standard Deviation Factor defect porous concrete column structure

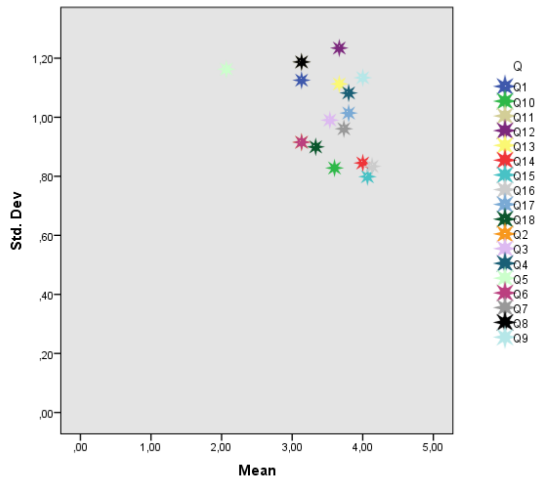

Fig 4:- Diagram of Mean - Standard Deviation defect factor porous structure of concrete columns

In the picture above shows that each variable groups in mean values between 3 and 4, so that it can be described average respondent answered quite agree and agree that each variable affects the defect porous concrete column structure.

- Factors causing the defect within a point of foundation

No.	Factors pile defect distance point is not according to plan	mean	Std. dev	Rank
Q6	Lack komunakasi with planning consultant and owner	4.067	0.961	1
Q5	Piling equipment operator can not understand the working drawings	4,000	1,069	2
Q8	Too fast in execution to avoid delays	4,000	1,195	3
Q4	Non-compliance and working procedures	3.933	0.704	4
No.	Factors pile defect distance point is not according to plan	mean	Std. dev	Rank
Q9	The lack of experience of the operator tool used.	3.933	0.594	5
Q13	Not ratanya land surface area of the location of erection	3.867	0.640	6
Q15	Less detailed determination of the sequence As erection (erection sequence number)	3,800	0.676	7
Q14	The absence of maneuver simulation plan drawing tool on erection	3,733	0.884	8
Q2	Ignore the request and instruction owner	3,733	0.594	9
Q10	Lack of teamwork and coordination of field workers	3,667	0,816	10
Q3	Lack of commitment to quality assurance and quality control	3,667	0.724	11
Q12	Pemancang tool that he was already old	3,400	0.910	12
Q1	Lack of periodic checks during the process of construction	3,400	0.986	13
Q16	Less details Setting Out point corresponding coordinates stake	3,333	0.724	14
Q11	Pemacangan tool that treatment is less so the accuracy and precision are not appropriate	3,333	0.976	15
Q7	Lack of expertise implementers	3,200	0.775	16

Table 4. Mean and Standard Deviation Factors defect within a point of foundation

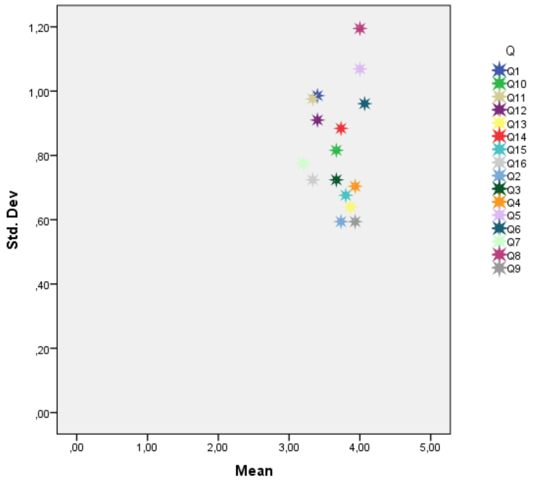

Fig 5:- Diagram of Mean - Standard Deviation distance point defect factor foundation

In the picture above shows that each variable groups in mean values between 3 and 4, so that it can be described average respondent answered quite agree and agree that each variable affects the defect of concrete pile foundation point distance is not according to plan.

D. Improve phase

In this phase of corrective actions related to recommendations based on the analysis that has been done before. Recommended action solution obtained from the interview to the specialist in providing alternative solutions on measures based on factors that influence.

R.1	Check the cleanliness of working tools, formwork examination (form work), reinforcing checks, termination of casting.
R.2	To check the suitability of the design of the column before it closed formwork
R.3	Made a checklist and approval of desired material before pouring concrete
R.4	Made a checklist and approval of desired material before pouring concrete
R.5	Directed workers pouring concrete on procedures to manually or with mechanical vibrator
R.6	Coordinate with the provider of cast concrete to ensure the delivery schedule
R.7	Placing Concrete pump truck as close as possible to the casting area to avoid the risk of segregation
R.8	Make a schedule for maintenance work (Curing)

Table 5. Recommendations for action to defect structure of porous concrete columns

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R.1	Conducting surveys and uitzet point position foundation with project participants.
R.2	To check the suitability of the design of the column before it closed formwork
R.3	Using specialist subcontractors in the field of foundation
R.4	Doing permit stages include land preparation, material and equipment
R.5	Take measurements as auxiliary pole to point at a depth of 2 meters using waterpass / theodolite
R.6	Monitoring the pole axis eccentricity tolerance predefined

Table 6. The recommendations for action to defect within a point of foundation

After getting a recommendation of remedial measures, the next step is done give the relationship between the causes and corrective action recommendations, the assessment is done by questionnaire and analyzed by the method of Quality Function Deployment (QFD).

* Relations with recommendations for action and the causes of defect structure of porous concrete columns

		Recommendations for action solutions defect structure of porous concrete columns							
factors defect	mean	R1	R2	R3	R4	R5	R6	R7	R8
Q16	4.133	1.67	1.33	1.00	2.33	9.00	2.33	1.67	-
Q15	4.067	1.67	1.00	3.67	1.67	3.67	1.67	7.00	-
Q14	4,000	5.00	9.00	1.67	1.67	3.67	-	0.33	0.33
Q9	4,000	2.33	7.00	1.67	9.00	9.00	1.00	1.67	5.00
Q17	3,800	9.00	2.33	2.33	1.00	5.00	2.00	5.00	-
Q4	3,800	9.00	9.00	9.00	7.00	7.00	1.00	1.67	9.00
Q7	3,733	3.33	7.00	7.00	7.00	3.00	9.00	7.00	9.00
Q13	3,667	7.00	2.33	0.33	0.67	0.67	0,00	0.33	-
Q12	3,667	0.67	0.67	0.67	0.67	1.67	0,00	0.67	2.00
Q10	3,600	3.67	5.00	2.33	3.67	3.00	1.67	1.67	5.00
Q3	3.533	9.00	9.00	5.00	2.33	2.33	7.00	5.00	7.00
Q18	3,333	1.67	1.00	1.00	7.00	5.00	9.00	3.00	0.67
Q2	3.133	5.00	4.33	5.00	4.33	5.00	5.00	1.67	5.00
		Recommendations for action solutions defect structure of porous concrete columns							
factors defect	mean	R1	R2	R3	R4	R5	R6	R7	R8
Q6	3.133	1.67	2.33	7.00	1.67	1.00	2.33	0.67	1.67
Q1	3.133	9.00	7.00	3.00	3.00	5.00	3.00	7.00	1.67
Q11	3.133	1.00	0.67	1.67	1.67	7.00	-	1.67	0.33
Q8	3.133	4.33	2.33	1.67	9.00	2.33	9.00	5.00	5.00
Q5	2,067	0.33	1.00	0.67	1.33	0.67	0.33	0.67	0.67
total Score		269	261.2	193.4	229.6	268.9	187.4	183.6	185.6
Ranking Recommendation		1	3	5	4	2	6	8	7

Table 7. Assessment and recommendations relationship factor defect structure of porous concrete columns

* Relations with recommendations for action and factor defect within a point of foundation

		Recommendations for action to defect pile distance point not according to plan					
factors defect	mean	R1	R2	R3	R4	R5	R6
Q6	4.067	9.00	9.00	5.00	9.00	2.33	4.33
Q5	4,000	7.00	2.33	5.00	5.00	2.33	1.67
Q8	4,000	7.00	2.33	5.00	7.00	5.00	4.33
Q4	3.933	5.00	1.00	9.00	9.00	7.00	7.00
Q9	3.933	1.67	1.67	9.00	5.00	7.00	3.67
Q13	3.867	5.00	1.67	1.00	7.00	5.00	4.33
Q15	3,800	2.33	9.00	1.00	1.67	1.67	1.67
Q14	3,733	1.00	4.33	7.00	1.00	1.67	1.00
Q2	3,733	1.67	5.00	5.00	7.00	5.00	5.00
Q10	3,667	5.00	5.00	5.00	5.00	2.33	5.00
Q3	3,667	1.00	2.33	1.67	4.33	3.67	7.00
Q12	3,400	0.33	0.67	5.00	5.00	2.33	0.67
Q1	3,400	5.00	2.33	2.33	5.00	3.67	7.00
Q16	3,333	2.33	1.67	1.67	6,33	5.00	1.00
Q11	3,333	0.33	0.67	6,33	7.00	4.33	0.67

Q7	3,200	1.67	5.00	7.00	2.33	5.00	1.67
total Score		211.3	202.1	282	323	233.9	210
Ranking Recommendation		4	6	2	1	3	5

Table 8. Relationship factors and recommendation defect within a point of foundation

E. phase Control

The recommendations remedial measures useful for the next stage of the process work, in this study the results with recommendations for action on the improve phase is used to determine how much the probability of sigma level rise if the recommendations were calculated using monte carlo simulation.

1. Probability value of the minimum and maximum recommendations for action

Recommendation	Minimum probability sigma level	The maximum probability sigma level
R.1	0.416	0.605
R.2	0,404	0.587
R.3	0,299	0.435
R.4	0.355	0.516
R.5	0.416	0.605
R.6	0.290	0.421
R.7	0.284	0.413
R.8	0,287	0.417

Table 9. Min-max probability recommendations defect structure of porous concrete columns

Recommendation	Minimum probability sigma level	Maximum probability sigma level
R.1	0.546	0.763
R.2	0.530	0.741
R.3	0.393	0.549
R.4	0.466	0.652
R.5	0.546	0.763
R.6	0.380	0,532

Table 10. Min-max probability recommendation defect within a point of foundation

2. Standard deviation and Absolute Error

Of the minimum and maximum value can be known the value of a standard deviation, and to seek absolute error then determined the expected relative error is 5%. Here are the results of the calculation are looking for absolute error:

Absolute error (Ɛ) = (Relative error) x (measured value) (2)

- Absolute error defect action on concrete columns:

(Ɛ) = 0.05 x 3.375 = 0.169 (3)

- Absolute error defect action recommendations within the foundation:

(Ɛ) = 0.05 x 3.43 = 0.172 (4)

3. Value Iteration

Value is the value of the loop iteration in which the number of iterations performed to determine the level of accuracy achievement sigma level.

- Calculation iteration defect on porous structure of concrete columns:

$$\left(\frac{3x0,8838}{0,169}\right)^2 = 245 \quad (5)$$

iteration	R.1	R.2	R.3	R.4	R.5	R.6	R.7	R.8	Amount
Min	0.415	0.403	0,299	0.355	0.415	0.289	0.283	0.286	2.75
Max	0.604	0.587	0.435	0.516	0.604	0.421	0.412	0.417	4.00
iteration 1	0.474	0.469	0.326	0.453	0.501	0.319	0.352	0.295	3,192
iteration 2	0.598	0.576	0.426	0.441	0.554	0.335	0.309	0.344	3,586
iterati	0.4	0.4	0.3	0.4	0.4	0.3	0.3	0.3	3,291

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on 3	57	98	37	24	91	37	66	77	
iteration 4	0.491	0.520	0.335	0.430	0.533	0.405	0.300	0.357	3.374
....	....	....	....	....	....	....	....	....	....
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iteration 245	0.572	0.436	0,363	0.454	0.585	0.399	0.405	0.415	3.632

Table 11. Iteration sigma level defect on porous structure of concrete columns

In the above table the known value of the iteration level to the sigma-245 is 3.63 this value can be achieved when the eighth recommendation do. In this study also simulate five scenarios with recommendations for action when the eight recommendations are not implemented fully in order to know sigma level of several scenarios.

Scenario	Recommendation implemented								level
	R1	R2	R3	R4	R5	R6	R7	R8	sigma
scenario 1					✓	✓	✓	✓	3.158
scenario 2	✓	✓	✓	✓					3.222
scenario 3			✓	✓	✓	✓			3.185
scenario 4	✓	✓					✓	✓	3.195
scenario 5	✓	✓	✓	✓	✓	✓	✓	✓	3,630

Table 12. Scenario recommendation defect structure of porous concrete columns

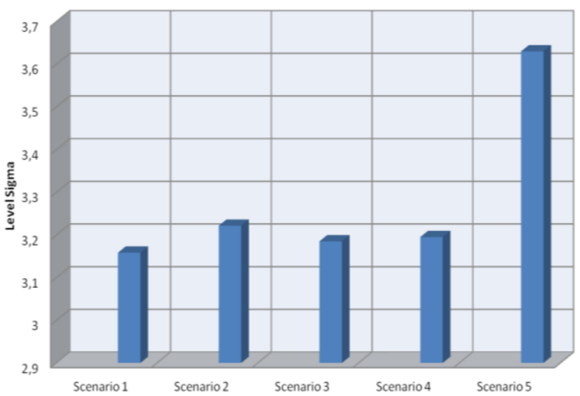

Fig 5:- Graph simulation scenario sigma level defect on porous structure of concrete columns

- Calculation iteration recommendations for action within a point defect piles not according to plan:

$$\left(\frac{3x0,806}{0,172}\right)^2 = 199 \quad (6)$$

iteration	R.1	R.2	R.3	R.4	R.5	R.6	amount
Min	0.545	0.529	0,392	0.465	0.545	0.380	2,86
Max	0.763	0.741	0,548	0.651	0.763	0,531	4.00
iteration 1	0.603	0.655	0.472	0.543	0.573	0,509	3.35
iteration 2	0,629	0.631	0.410	0.626	0.634	0.454	3.38
iteration 3	0.709	0.604	0,407	0.533	0.553	0.508	3.317
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
iteration 199	0.580	0.616	0.487	0.649	0.652	0.503	3.48

Table 12. Iteration sigma level Recommendations defect within a point of foundation

In the above table the known value of the iteration level to the sigma-199 was 3.48 this value can be achieved when the sixth recommendation do. In this study also simulated four scenarios on the eighth course of action if they are not implemented fully in order to know sigma level of several scenarios.

Scenario	Recommendation implemented						level sigma
	R1	R2	R3	R4	R5	R6	
scenario 1	✓	✓	✓	✓			3.279
scenario 2			✓	✓	✓	✓	3.247
scenario 3		✓	✓	✓	✓		3.279
scenario 4	✓	✓	✓	✓	✓	✓	3,480

Table 13. Scenario recommendation defect within a point of foundation

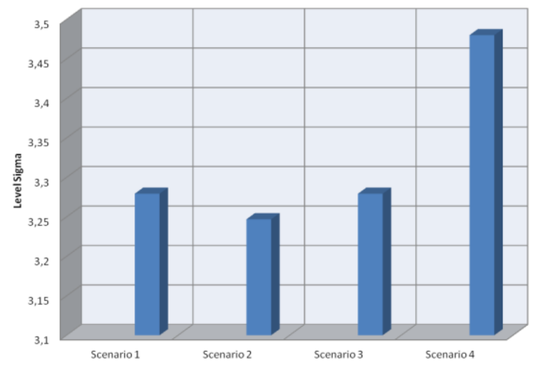

Fig 6:- Graph simulation scenario sigma level recommendations within point defect foundation

V. CONCLUSION

Defect construction work under three-sigma level defect column structure of porous concrete work with sigma level of 2.75 and the distance point of the foundation is not in accordance with the plan sigma level of 2.86. Both types of defects are located below the average for the construction industry. Factors that influence the occurrence of defects porous concrete column structure as much as 18 variables, and the factors that most influence is less than perfect compaction factor when casting. For factors that influence the occurrence of a point defect within the foundation is not according to plan as much as 16 variables and the most influencing factor is lack komunakasi with planning consultant and owner. In the simulation scenario action recommendations to improve the sigma level in order to be at level three.

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