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Research Article

Enhancing Lifetime Protection of Civil Structures with Coating Modification using Rice Husk Ash at Integrated Terminal Balongan

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Abstract – PT Pertamina Patra Niaga West Java Region is an investment implementation function based on the budget written in RKAP of each period. The investments carried out are spread in each work location at Jakarta, Banten and West Java. Integrated Terminal Balongan is one of the Main Transit Fuel Terminals in the Pertamina Patra Niaga – West Java Region. Based on the pareto diagram analysis, the main cause for the short lifetime protection of civil structures at Integrated Terminal Balongan was the the mismatch between the design and the actual conditions in the field. To overcome this problem, Coating modification using Rice Husk Ask is determined as alternative solution of common coating of civil structures. By applying this alternative solution, the Quality of Civil Structure (lifetime) increased from 2 years to 4,8 years, reducing construction cost 18,4% (IDR 40.470 / m2) and in addition, the acceleration of the work of construction of civil structure coating is as much as 4 Calendar Days (curing time)

This innovation has been endorsed by an external party, PT Surveyor Indonesia, PT. Sucofindo and Institut Teknologi Bandung. Replication has been carried out for the Fuel Terminal PT. Pertamina Patra Niaga – West Java Region and Regional Sulawesi.

Keywords: Civil Structure, Rice Husk Ask, Coating Modification, Enhancing Life Time Protection.

Introduction

Integrated Terminal Balongan is one of the main transit fuel terminals in the Pertamina Patra Niaga West Java Region. The problem that has the most significant financial impact, namely the "Operating Cost Budget Maintenance" project with a financial impact of IDR 118.904.000.000 years to date (2023). In the construction phase, the construction cost of civil structure coating are determined as the main focus of the research due to its status as highest operating cost budget maintenance. The construction cost of civil structure coating made the highest cost of IDR 71.343.000.000.,- . By doing so, the construction cost of civil structure coating supposed to be the focus of the problem solving.

Table 1. Operating cost budget at Integrated Terminal Balongan

No	Operating Cost Budget	Total Budget year to date 2023 (IDR)
1	Filling Shed	71.343.000.000
2	Tank Foundation	24.970.000.000
3	Pier	22.592.000.000

Followed by using cause and effect analysis, there are 3 (three) potential root cause which are: There Aren't Subtitute Material Coating (A) (Abdullah et al., 2021) ; There aren't surface prepration tools (B); There aren't coating tools (C). According (Fig. 2), point A has the highest value to be the root cause.

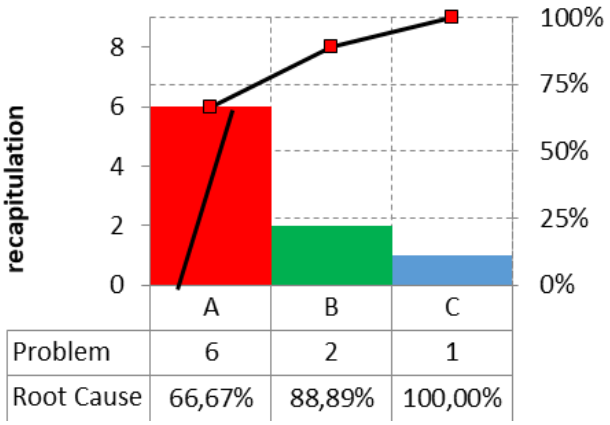

Fig. 1. Pareto for Root Cause

The highest root cause for the problem is there aren't substitute material for modification of civil structure coating. It should be our focusses to bring material substitute in order to increase the quality of coating and reduce construction cost of civil structure coating.

Analysis

With the the high construction cost of civil structure coating problem, we have 3 (three) alternative solution that can reduce high construction cost. The choosing of alternative solution can be seen in Table 2. Coating modification using Rice Husk Ask is chosen due to low effort high impact of implementation.

Table 2. Choosing an Alternative Solution

Root Cause	Alternative Solutions	Cost Estimate	Duration Implementation	Low Effort High Impact	Chosen Solution
The high construction cost of civil structure coating	FRP (Fibre Reinforced Polymer) Coating	High	Fast	Low Effort High Impact	Coating modification using Rice Husk
	Asphalt Coating	Low	Slow	Low Effort Low Impact	
	Coating modification using Rice Husk	Low	Fast	Low Effort High Impact	

Before this research conducted, the implementation of civil structure coating Pertamina Patra Niaga always uses conventional civil structure coating refer as per NACE (National Association of Corrosion Engineers). The first use of coating modification using Rice Husk was carried out in the Pertamina Patra Niaga West Java Region because it cannot be found on the KOMET portal for similar innovations. In addition, the uniqueness of coating modification using Rice Husk are utilizing local raw materials and contributing to the utilization of micro enterprises in the area and also Rice Husk Ask is a natural and environmentally friendly material that is abundant in Indonesia so it has a replicability value. (Haryono et al., 2010)

Trial and Error System

Trial and error obtanied after we conduct sample test as shown in table 3. Test conducted in Kansai Laboratory , Jakarta at second layer of coating consist of pull off test & salt spray test.

1. Pull Off test

Table 3. Test Result of Sample

Extract Risk Husk Ask + ZnO (gr) Composition	Sample	Bonding Agen (%)	Cohesive Failure	Pull Off Strength (Mpa)	Average (Mpa)
0	1	44,8	54	7,04	6,0433
	2	15	85	5,29	
	3	7,9	91	5,8	
2	1	30,2	69	6,8	6,8033
	2	44,2	54	5,6	
	3	35	63	8,01	
4	1	47	51	5,73	7,9867
	2	42	58	10,01	
	3	8	92	8,22	
6	1	98	1	7,89	7,3633
	2	21	79	6,2	
	3	20	80	8	

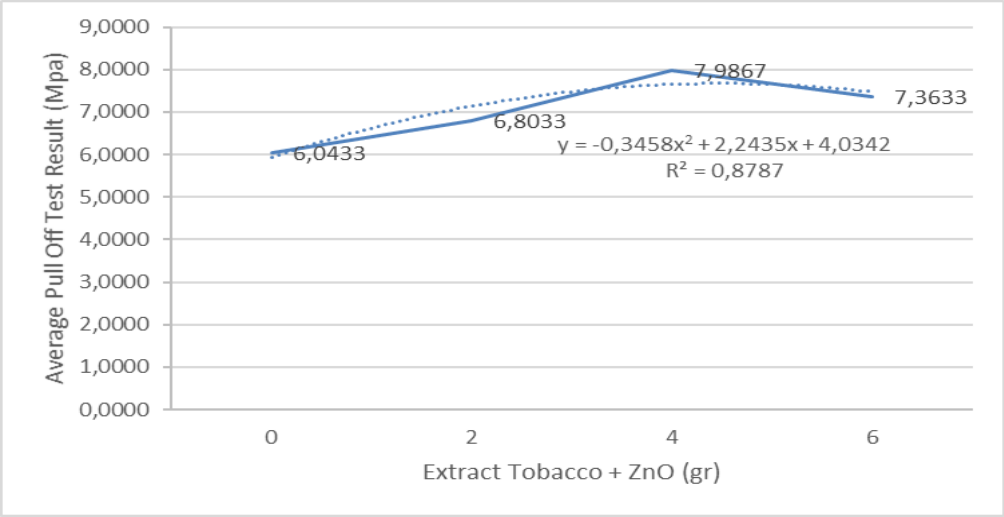

Fig. 2. Trendline Pull Of Test Result

As per table 3 and fig. 4 shown that optimal compressive strength can be obtained from formula :

$$x\ optimum = \frac{-b}{2a}$$

= - 2,2435/-0,3458

= 3,24 gr.

coating modification using Rice Husk have an optimum Pull Off Test result with composition 3,24 gr mass Extract Rice Husk Ash + ZnO base with polyurethane as binder 10:1 composition.

2. Salt Spray test

Table 4. Salt Spray Test Result

No	Extract Rice Husk Ask + ZnO (gr) Composition	Blister	
		Size µm	frequency (qty per cm2)
1	0	8	12
2	2	6	4
3	4	7	6
4	6	9	8

Table 4. shown that salt spray test result optimized at range 2-4 rice husk ash + Zno (gr) composition. Too much composition rice husk ash make size of blister higher and frequency of blister higher too. The results mean that the homogeneous coating material particles have good coating quality so as to minimize triggers occurrence of corrosion. (Sumberdaya et al., n.d.)

From the trial and error results obtained on the Table 5 Trial 3 process is the most effective process for making coating modification using Rice Husk Ash.

Table 5. Trial and Error coating modification using Rice Husk

No.	Trial & Error	Trial 1	Trial 2	Trial 3
1	Storage Method	Glass Bottle (Difficulty in storage handling, Expensive)	Anaerob Plastic Sealed (Easy leakaged, difficulty in storaging handling)	Plastic Bottle, (Effective)
2	Alkaloid Content	40mg per 100 gr (effective)	40mg per 100 gr (effective)	40mg per 100 gr (effective)
3	pH	7,5-8 Optimal	7,5-8 Optimal	7,5-8 Optimal
4	Dosage in Bonding Agent	3:10 (expensive)	2:10 (moderat)	1:10 (cheap)

Result and Discussion

Data after implementation shown in Table 6. is based on the news on the Field of Integrated Terminal Balongan.

Table 6. Before After Implementation Comparison Root Caused Problem

Root Cause		Rank	Existing			After the Implementation		
			Frequency	%	% Cum	Sum	%	% Cum
A	There Aren't Subtitute Material Coating	**1**	**6**	66,67%	66,67%	**0**	**0**	**0**
B	There aren't surface prepration tools	**2**	**2**	22,22%	88,89%	2	66,66%	66,66%
C	There aren't coating tools	**3**	**1**	11,11%	100,00%	1	33,33%	100,00%
Total			**9**	**100%**		**3**	**100%**	

Coating modification using Rice Husk Ash can solve root caused problem A (There Aren't Subtitute Material Coating) . In the other hand, it can't solve root caused B (There aren't surface prepration tools) and (C) There aren't coating tools because it still need tools for surface preparation and coating tools to do the work. (Industri, 2018)

Data after implementation for Quality of coating modification using Rice Husk for civil structure coating on Integrated Terminal Balongan shown in Table 6.

Table 6. Quality of coating modification using Rice Husk Ash

Extract Rice Husk Ash+ ZnO (gr) Composition		Pull of Test average (Mpa)	Blister	
			Size µm	frequency (qty per cm2)
Batch 1	3,24	6,74	6,5	5
Batch 2	3,24	6,62	6,8	6
Batch 3	3,24	6,80	6,4	5
Batch 4	3,24	7,01	6,4	7
Batch 5	3,24	6,50	6,6	6

Coating modification using Rice HuskAsh can increase Quality Pull Off Test from 6,04 Mpa to average 6,73 Mpa. In addition with blistering calculation approach, Coating modification using Rice HuskAsh can increase life time of steel structure marine coating (Ong et al., 2021) from 2 years into 4,8 years. Coating modification using Rice HuskAsh can accelerate project 4 Calender days compared with conventional civil structure coating due to shorter curing time.

Data after implementation for construction cost of Coating modification using Rice HuskAsh on Integrated Terminal Balongan shown in Table 7.

Table 7. Construction Cost of Coating modification using Rice HuskAsh

Civil Structure Coating	Cost (IDR) / m2	Efficiency
Total Cost Coating DFT 250 Micron	220.052,00	18,4%
ACDC (Anti Corrosion with Extract Tobacco)	179.581,24	

As per table 7 shown that Construction Cost of Coating modification using Rice HuskAsh on Integrated Terminal Balongan can be reduced 18,4%.

Summary

Coating modification using Rice HuskAsh can be used as an alternative to conventional civil structure coating because they achieve the Quality Cost & Delivery targets as targeted in this innovation. The results showed that:

1. Coating modification using Rice HuskAsh were considered able to reduce Construction Cost of Coating, especially in the Civil Structure Coating Cost.
2. Coating modification using Rice HuskAsh were considered able to increase quality (Pull Off Strength and lifetime of coating)
3. Coating modification using Rice HuskAsh were considered able to Accelerate project due to shorter curing time.

The application of innovative Coating modification using Rice HuskAsh has received testimony from internal management and External Stakeholder.

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