Anti-radiation Building Design: Consistency of Linear Attenuation Coefficient in Black Sand South Beach Diy Province to Get the Best X-Ray Radiation Resistance Concrete

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Abstract. Radiation protection is one of the external radiation protection efforts. Concrete is the material for making external radiation shields other than lead, steel, and other heavy materials. According to [2], concrete material for a good radiation shield is made from sand from the south coast of Yogyakarta with an average linear attenuation coefficient value of 0.801697695 cm^(-1) and an HVL value with an average of 0.865070204 cm. Therefore, this study aimed to determine the consistency of sand from Parangtritis beach to Congo beach influencing the linear attenuation coefficient of radiation shielding concrete.

The research used is to use a sample of beach sand moulded into concrete with a size of 20 cm^2 with a thickness of 5 cm and then mixed. Data analysis was carried out using the equation $Dx = Do.e\text{-}\mu x$ to get the linear attenuation coefficient value. The data obtained are compared to determine the consistency of beach sand in affecting the linear attenuation coefficient of radiation shielding concrete.

The study's results showed that the highest liner attenuation coefficient was produced by concrete with the primary material of Trisik beach sand with a value of 1.314044724 cm^(−1). On the other hand, the lowest linear attenuation coefficient value is produced by concrete based on Parangtritis beach sand with a value of 0.939604673 cm^(-1), so that beach sand from Parangtritis beach to Congo beach does not have consistency in influencing the attenuation coefficient of the anti-radiation concrete liner.

Keywords: consistency of sand beach · coefficient of linear attenuation · hvl

1 Introduction

According to [6], radiation is the emission of energy from waves or particles emitted from radiation sources or radioactive substances. Radiation protection is divided into two, namely internal and external radiation protection. Internal radiation protection is generally carried out when the radiation source is inside the patient's body. External radiation protection is carried out because the radiation source is outside the patient or human body. Three principles of external radiation protection must be known, namely distance, time, and shielding (shield) [8].

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According to [1], There are at least three principles for radiation protection, namely justification, limitation, and application of radiation optimization and safety. According to [5], materials that can be used as radiation shields include concrete, lead, steel, and other heavy materials. A material absorbs radiation or commonly known as the coefficient of attenuation. The absorption ability of a shield becomes smaller when used in high-energy radiation beams with a sizeable penetrating power, which means the attenuation coefficient of the shield will also be small.

According to [2], a good concrete material for radiation shielding is a mixture of cement with the type of sand on the south coast of Yogyakarta because it has a high linear attenuation coefficient value with an average value of 0.801697695 cm−1 and HVL value is low with an average of 0.865070204 cm compared to other sands. So it is concluded that a good concrete to be used as a radiation shield is a mixture of cement and sand from the south coast of Yogyakarta.

Beach sand or iron sand has excellent and round grains. However, it requires special treatment to reduce the salt content so that volume expansion does not occur if used for building materials or concrete. In addition, please be aware that beach sand on the land is still affected by the sea (strong winds, tides, seawater seepage). The sea is still affected by natural processes that occur on land so it may affect the quality of any beach sand or iron sand [4].

In the research conducted [2], it has yet to be discovered whether the southern coast of Yogyakarta, starting from Parangtritis beach to Congo beach, has the same value for the linear attenuation coefficient and its HVL, So it is necessary to do further research to determine the consistency of linear attenuation of beach sand starting from Parangtritis beach to Congo beach.

2 Research Methods

This research is an experimental study to determine the consistency of beach sand starting from Parangtritis beach to Congo beach as the primary material for anti-radiation concrete. This research was carried out at the Radiology Laboratory of the University of 'Aisyiyah Yogyakarta, which was carried out from August 2019 to April 2020. The tools and materials used in this study were as follows: Tool (Xrayplane, detector, laptop device using excel, Concrete moulding tools), and Consumables (Water, beach sand (parametritis beach to congot beach gresik brand comment, scoring form) (Fig. 1).

A. *Implementation Method*
1) *The procedure for making concrete is as follows:*

- Make a concrete mould of 20 cm × 20 cm with a thickness of 5 cm (Fig. 2)
- Washing the beach sand using fresh water reduces the salt content of the beach sand.
- Mix cement with beach sand in a ratio of 1:3.
- Add enough water, then mix the cement and sand until evenly distributed.
- Print the dough that has been mixed evenly on the wooden mould that has been prepared (Fig. 3).
- Dry the mould under the hot sun for approximately 3–5 days.

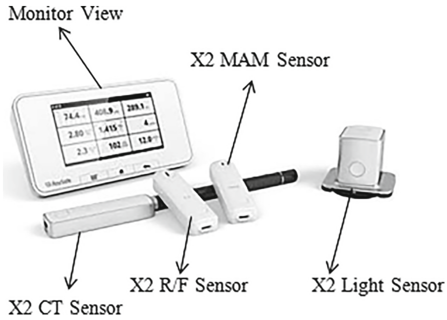

Fig. 1. Raysafe X2 set

Fig. 2. Tools for Casting Concrete

Fig. 3. Concrete moulding process.

- Remove the dry concrete from the mould.

2) Concrete testing procedure:

- Test the initial intensity of the X-ray machine by irradiating the detector with radiation for 5 exposures and recording the initial radiation intensity without a barrier (concrete) on the assessment form (Fig. 4).
- Place the concrete between the detector and the X-ray tube, then irradiate 5 times on each concrete (Fig. 5)

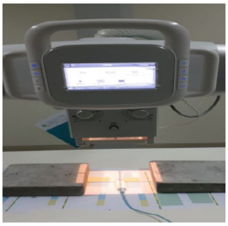

Fig. 4. Taking Radiation Intensity Without Retainer

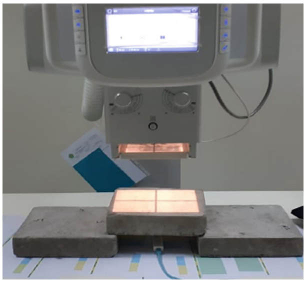

Fig. 5. Radiation Intensity Taking with Concrete Retainer.

- After getting the radiation intensity value of each concrete, the next step is to analyze the data with the equation Dx = Do. e-μx to find the value as follows:

$$D_x = D_\circ .e^{-\mu x}$$

  It means:
  Dx = is the rate of absorbed dose after passing through a barrier of thickness x.
  Do = is the dose rate pre-absorption without retaining x. thick
  X = is the thickness of the retainer.
  μ = is the coefficient linear attenuation of retaining a material.

- Find the half value layer (HVL) with the equation HVL = ln2/μ to get a good concrete as a shield against X-ray radiation as follows:

$$HVL = \frac{ln2}{\mu}$$

  It means:
  ln2 = 0,693
  μ = is the coefficient linear attenuation of retaining a material

3 Result

Study of beach sand consistency for the manufacture of anti-radiation concrete with FFD setting of 60 cm and exposure factor of 75 kV, tube current of 400 mA and irradiation time of 16 ms. Before analyzing the radiation intensity of the concrete, it is necessary to find the value of the radiation intensity without using a concrete retainer and the radiation intensity with a concrete retainer, presented as follows (Table 1).

After obtaining the radiation intensity value by using a retainer or without a barrier, it is analyzed using the equation Dx = Do. e^(-μx) to find the value of and HVL = ln2/μ to find the thickness of the material.

The results of the calculation of the value of and HVL of the entire concrete with the basic ingredients of south beach sand starting from Parangtritis beach to Congo beach are then presented in Table 2.

According to [8], concrete with beach sand as the basic material is not recommended to be used as the basic material for making concrete. However, according to [9], beach sand can be used as a concrete base material with special treatment, namely by washing the sand with fresh water so that the salt content in the sand is reduced or lost.

The research that has been carried out uses the following materials and equipment: Samsung brand X-ray aircraft, Paysafe detector with R/F sensor, laptop, concrete and assessment form instruments. The concrete used in this study is concrete with beach

Table 1. Radiation Intensity without Retaining and using Concrete Retainer.

Expose nomor	***Do (mGy)***	***Dx (Dosis setelah menggunakan penahan beton)nGy***					
		Parangtritis Beach Sand	***Samas Beach Sand***	***Trisik Beach Sand***	***Pleret Beach Sand***	***Baru Beach Sand***	***Congot Beach Sand***
1	2,658	2475,6	6021,6	2842,4	8991,8	4765	3916,2
2	2,658	19366	7838,2	3262,8	110260	5739,2	4068,4
3	2,603	3102,8	7599,4	3068,6	10392	4364,6	4190,2
4	2,658	25304	7589,4	3079,2	12134	4941,4	3956,8
5	2,603	1719,4	9413,2	1923,8	9672,4	5351,8	2758
Average	2,636	23530	7692	2835	10443	5099,3	3778

Table 2. Average Value of Radiation Intensity in Concrete with Beach Sand Base Material.

No	**Beach Sand**	**Average**	
		μ cm^(-1)	***HVL(cm)***
1.	Parangtritis	0,939604673	0,739010004
2.	Samas	1,145699713	0,605574189
3.	Trisik	1,314424	0,527962954
4.	Pleret	1,100706542	0,629965305
5.	Baru	1,245739773	0,556596094
6.	Congo	1,299916959	0,53326169

sand as the basic material starting from Parangtritis, Samas, Trisik, Baru, Planet, and Congo beaches with a ratio of cement and sand composition of 1:3 with a size of 20 cm × 20 cm and a concrete thickness of 5 cm.

In assessing the consistency of the radiation intensity of each concrete, it is necessary to know in advance how to assess whether or not concrete will be used as a radiation barrier. According to [5], the smaller the linear attenuation coefficient means the ability of the material to absorb radiation is also lower and vice versa.

The researchers found that the results of the radiation intensity in each concrete that was tested were inconsistent in influencing the linear attenuation coefficient; it can be seen in the average value of the attenuation coefficient of each concrete. In addition, the researchers also looked at the differences in the physical characteristics of each tested beach sand that might affect the quality of the sand.

[2] explains that a good basic material for the manufacture of anti-radiation concrete is the southern beach sand of Yogyakarta, where the sample taken is Parangtritis beach sand with a value of 0.801697695 cm−1 and HVL 0.865070204 cm. However, the researchers found that the beach sand which has a higher value and a lower HVL is Trisik beach sand with a value of 1.314044724 cm−1 and an HVL value of 0.527962954 cm, so that Trisik beach sand is more durable. It is recommended to be used as a basic material for the manufacture of anti-radiation concrete.

4 Conclusion

After knowing the results of research related to the consistency of beach sand for the manufacture of anti-radiation concrete, it can be concluded that beach sand from Parangtritis beach to Congo beach does not have the same consistency in influencing the linear attenuation coefficient of anti-radiation concrete. The highest linear attenuation coefficient value is produced by concrete with Trisik beach sand base material with a value of 1.314044724 cm−1 and an HVL value of 0.527962954 cm, and the lowest linear attenuation coefficient value is produced by concrete with beach sand base material. Parangtritis with a value of 0.939604673 cm−1 and an HVL value of 0.739010004 cm.

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