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Repair techniques in Underwater Pipelines for Drinking Water

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Abstract. Changes in sea weather, especially the strait facing the open sea, will greatly affect inter-island underwater drinking water pipelines, which can cause damage to pipelines made from High Density Polyethylene (HDPE). Damage that often occurs is broken or folded, so repairs will be difficult given the position of the damaged pipe is at the bottom of the sea, so that special needs to be repaired. Repairing underwater drinking water pipes is done by lifting pipes from the seabed with floats made of plastic drums. After the pipe is lifted from the seabed to the surface of the sea water the pipe will be connected in accordance with the connection procedure and subsequently drowned again by installing ballast. The length of the pipe raised to the surface of the sea is taken at least 1.5 depth of the sea on the damaged pipe making it easier to repair or reconnect. To lift one side of an underwater drinking water pipe type HDPE PN.10 bar with a diameter of 110 mm that breaks at a depth of 42 m requires a float of 13 units to be installed on a ballast concrete 6 m apart. Keywords: underwater pipelines, drinking water

1. Introduction

Underwater drinking water pipelines built between islands are always installed in a strait, some of which are strait facing the open sea, such as those in the Limbo Strait which is located between the Taliabu island and Limbo island in North Maluku, which is about 4 nautical miles. Sea current conditions which in certain conditions can reach 9 m/s greatly affect the stability of underwater drinking water pipes that have been installed. So that if there is damage at the bottom of the sea will be very difficult process of repair (connection). So we need an easier way to do repairs according to the availability of equipment and local labor [1-2]. The location of subsea pipelines that are not available with high-tech facilities for the repair process requires a solution that is easier and simpler to repair [3-4]. This is very important so that repairs do not last long so that drinking water services can continue to be carried out continuously.

Damage to drinking water pipes installed at the bottom of the sea with HDPE pipe material is a change in shape (buckling), folded and also broken [4-5]. Repairing pipes at the bottom of the sea will be difficult if it is not raised to the surface, because work at sea requires specialized equipment with professional staff. In addition to the safety risks of workers the risk of failure to work on the pipeline at sea is also quite high, especially if the conditions at sea level are quite heavy [6]. Things that need to be considered in lifting the pipe is the calculation of the weight of the pipe and the ballast concrete so that it can calculate the dimensions and the number of floats needed. Calculation of weight to be lifted and float can be calculated by equations 1, 2 and 3.



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Figure 1. Examples of underwater pipelines damage

$$F_A = \rho_{sw} \cdot V_{wm} \cdot g \quad (1)$$

$$w_{ow} = w_{oa} - F_A \quad (2)$$

$$w_{ow} = (\rho_c - \rho_{sw}) \cdot g \cdot V_{wm} \quad (3)$$

Where:

F_A = Archimedes style (N)

ρ_{sw} = Density of sea water (kg/m^3)

ρ_c = Density of concrete (kg/m^3)

V_{wm} = Volume of water displaced (m^3)

g = Acceleration of gravity (m/s^2)

w_{ow} = Weight of objects in water (N)

w_{oa} = Weight of objects in air (N)

2. Method

Simple and easy removal of pipes from the seabed for repair can be done with floats that can be made from plastic drum. The process of lifting the pipe from the bottom to the surface of the sea water is done by placing a float on the point of the pipe which is installed with ballast concrete. The floating process is done by submerging the plastic drum by filling the drum with water, so that it can be carried to the sea to be bound at the point to be lifted [7].

After all the drums have been filled properly, the diver must remove the water from the drum by spraying air from the compressor tube into the hollow drum section, so that the water from the drum exits and the air left in the drum will tighten the pipe and ballast upwards [8]. The process of erasing water from the drum is carried out from the endpoint to be repaired and continuously sequentially to the very back, so that the end of the pipe to be repaired or connected emerges to the surface of the sea water and subsequently repair or connection. After the repair process, the pipe must be submerged again. The adding ballast concrete to the part needed and releasing the drum in sequence from the deepest part.

3. Result and Discussion

Density of HDPE 959 kg/m³ pipe, then the pipe will float well in the empty and map filled condition, so that the load that needs to be lifted by the float is the weight of the concrete weight minus the buoyancy of the pipe which is assumed to be filled. From the calculation results obtained by weight of pipes and weights in water per unit of 74.94 kg, because the pipes installed in this study are double pipes and weights are installed close together at a distance of 6 m, then the weight of the ballast and pipes in water per-point is 146.95 kg, so it needs buoys with buoyancy greater than the weight to be lifted.

The float used is a platinum drum with an empty volume of 205 liters and has a buoyancy of 165 kg, so that one ballast point can be lifted with one drained drum [9-10]. Floating a 1.5 pipe from the length of the pipe then requires a minimum of 11 units of float drum. To simplify the process of connecting at two points the front end of the pipe to be joined added floats [11-13], so that in this case as many as 13 units of floating drums are used, the layout of which can be seen in Figure 2. Floating pipes and pipe joints can be seen in Figures 3 and 4. The connection process is carried out in accordance with the standard for PN 10 bar HDPE pipes, with an estimated connection time of about 40 min per point.

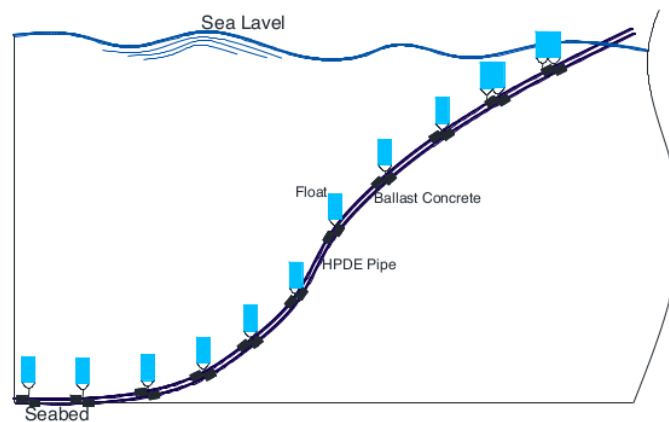


Figure 2. The layout of the float drum



Figure 3. Floats that arise on the surface



Figure 4. Pipe connection that has been floated

4. Conclusion

The process of repairing underwater drinking water pipes with HDPE pipe material and pipe weights in the form of K 500 concrete with ballast weights in the air 130 kg and in water 74.93 kg can be done with a float pastik drum which has a buoyancy of 165 kg. this method is very suitable to be applied because it does not require special equipment and can be done by local human resources. With a simpler way of repairing it will be able to guarantee the continuity of pipeline operations in carrying out water supply services to the community on the island of Limbo.

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