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The Effects of Poor Drainage System in Batam Road: A Case in Nagoya, Batam

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ABSTRACT

The poor drainage system is a big issue for giving good road construction quality. Because the beneath is a drainage system. Batam City is the fastest growing city in transportation wise, but the hydrological cycle creates floods in areas that have poor systematical performance. Despite its importance, the assessment of the Effects Poor Drainage System in Batam is far from enough. Sub-district Nagoya in Batam City is chosen as the research area due to having a poor drainage system and flooding when heavy rain falls. To assess this research, a survey is conducted on the field. The data is achieved by the qualitative method and compared the effectiveness of drainage systems to other advanced countries with great drainage systems. The result is shown that Batam City is far from having proper systematical drainage due to the buildup of garbage and sedimentation by sand and soil. Hence this still could result from overflow and cover the road pavements that could lead to a domino effect by scraping the asphalt aggregates, creating damages and effects such as potholes, puddles, traffic congestion, and accidents in the driveway.

1. Introduction

The poor drainage system has been a major issue for people to access roads. Because a functional drainage system is a significant factor to be considered envisaging and constructing good roads. A proper drainage system not only can carry wastewater and sanitation of the environment, but it can protect the road, structures, and streets from flooding, erosion, and potential potholes. Drainage issues can cause accidents in society. Not only can it cause roads to be flooded, but lane roads can also be covered, which can cause the vehicle to hit a sidewalk or run into a pothole that will lead to an accident. Hence, the government should reconsider using a proper material for road drainage systems and evaluate the soil sample before construction [1].

Transportation started from the development vehicle to the road. Although, developing countries like Indonesia need more road infrastructure to avoid traffic congestion. The government has made much effort to reconstruct road conditions, but due to poor drainage systems, roads can't be accessed because of puddles and flooding. Therefore, surface pavement gets covered in water that will cause the road to sink, causing potholes. The cause of flooded roads is poor drainage, which leads to a congestion factor that increases road damage because of traffic density [2].

Major Indonesian cities are experiencing traffic congestion because of the country's increasing automobile population [3]. Batam City is part of the Indonesia region, an industrial city with dense traffics in Indonesia. Where most of the areas are packed with pedestrians, cars, motor, truck containers, etc. But the facility government provided for the drainage system needs to be improved. Therefore, many areas need a proper drainage system that can handle rainwater, which will cause the water to slowly flood the road and eventually scrap the soil layer underneath the concrete road. So, the system can't function properly, which will cause the water to slowly flood and damage the concrete surface.

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Nagoya is a significant area in Batam that faces flood damage to road pavements. Due to Batam's population growth in each district, the hydrological cycle affects the urban drainage system the most. So, when Batam City is experiencing development, the drainage system should undergo improvement and repairs. In Nagoya, due to insufficient drainage, roads easily get covered when rain falls and will cause puddles. The puddle occurs because the drain can't handle much rainwater, so it will overflow and pool the road. That will cause the surface pavement to slowly get damaged by water and cause accidents [4]. This condition can cause discomfort and endanger road users and often occur vehicles to collide with one another due unable to control and anticipate the damaged road.

Due to Batam's population growth, land use will go through changes that will cause the risk of flooding bigger. Poor drainage systems and inadequate drainage systems cause this. This can create more complex issues like puddles, potholes, and accidents and interrupt local people's activities. But with Batam planning aspect of the drainage system still needs to be maximized, causing easy flooding everywhere and damaging concrete roads. Despite the importance, this study about the effect of poor drainage on surface pavements still needs improvement. In this study, Nagoya will be chosen as a sampling location. The cause of poor drainage, planning drainage construction, and impact on the people and environment will be studied. They may be used to evaluate issues and improvements in Batam City Nagoya drainage.

2. Literature Review

2.1 Poor Drainage

Proper drainage is the most important aspect before the construction of the road. The drainage system plays an essential role for urban residents. Because functional failure can trigger cascading effects on people's daily activity and critical damage to infrastructure such as roads [5]. It is not usual to find urban cities facing urban flooding due to bad drainage. Because the drainage system occupies a key position in the urban spatial analysis, acting in the interface between natural demands and the built environment needs.

While the natural water cycle demands a floodway to rainwaters that are gathered in the watershed, the urban environment demands safe and healthy places for urban activities and services. So, failures in the operation of urban drainage systems generate several potential damages, and losses to the daily city routine, and endanger citizens' life. The most global disaster due to poor drainage is flooding. These are capable of directly impacting the physical and mental health of the affected population and damage to infrastructure mainly roads such as scraping the asphalt that can slowly cause potholes.

An improved drainage system is needed to carry rainwater, sewage, etc. It must have perfect drafting before construction. Because the water handling system holds on road surfaces. So whenever a drainage system fails, road surfaces easily get damaged, which can make the water directly back onto the road. So excessive water on road surfaces combine with traffic action, will cause accidents, potholes, cracks, and pavement failure.

So drainage systems run alongside proper drainage roadsides are essential for collecting water from roads separating surface and environment and guiding them to exit points where it can be safely unloaded. With a high capacity of the drainage structure, it can convey high discharge and pressure because subsurface drainage is the crucial element for pavement design. This will prevent the water from getting backflow and flooding the city or covering the road pavements.

2.2 Traffic Congestion and Accidents

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Traffic congestion means traffic volume exceeds road capacity, leading to accidents [6]. Traffic congestion and accidents can occur from lousy drainage systems. An inadequate or poor drainage system will cause the capacity drainage can't hold a large volume of water that will quickly make the water back-flow and enter the highway road. Flooded roads can easily get damaged by water. Roads covered in water for an extended period can slowly scrap asphalt aggregate, loosen density and strength. That can cause potholes, road accidents, environmental damage, and potholes

Natural disaster flooding that is caused by bad drainage, can however cause structural failure (road inundation) and functional failure (reduced travel speed). So flooding could result from road closure and rerouting, which will cause drivers especially motorcyclist will be involved in an accident. This will increase demand on other road segments, which eventually worsens traffic congestion in the flooded area. So road inundation and traffic congestion can raise indirect failures on road and transportation

Based on the local observation in Nagoya, road inundations that cause congestion in traffic and accidents, partially can be attributed to several factors such as unnatural rainfall and poor drainage system. Unnatural rainfall will cause flooding due to the drainage capacity that cant hold large volumes of rainwater. This causes a large number of vehicles trapped in extreme congestion and rerouting roads because some areas can't be accessed due to road inundation. This trigger overload by flood water and vehicle will slowly damage the road.

So with heavy dense traffic plus flood, roads can get critical damage because of the weight of vehicles and water. This could lead to bad roads and cause discomfort for drivers and motorcyclists in driving. This causes a higher chance of accidents for the drivers. So this requires special attention from the public because it can cause a higher chance of accidents. So there must be a proper solution to overcome this.

2.3 Damages and Effects

Poor drainage system cause water flood that can lead to domino on roads sustainability such as creating road cracks, breaking down asphalt aggregate, potholes, road structure failure, congestion, and accident. Water flood will affect road conditions and layers. Floods and water will intensify the effect of roads sustainability because it has been identified as a major road issue and disturbance. Such as creating cracks and holes, vehicle crash, extreme congestion by rerouting, and etc [4].

Water and flood that cause cracks and potholes on surface road is still a major issue. Beside cracks and holes, it can cause accidents such as speeding. So with a country such as Indonesia, that has unnatural rainy season and poor maintenance it will cause accidents throughout the year making vehicles spare part gets scratched or damage and drivers life in danger. So poor maintenance will perform poor performance on the road that can cause discomfort in driving [7].

Flooding also cause extreme congestion on roads. Floods reduce accessibility roads, loosen daily people routine, and infrastructure. These effects on road system are critical towards transportation performance. Road inundation segments can impact network capacity, increase traffic volumes, worsen congestion, and accessibility. Although, accessibility location is the domino effect that create another issue, because accessibility is compact with insufficient road infrastructure and severe congestion. So traffic congestion must be addressed immediately so that the impact does not damage the surface pavement and surroundings [26] [27].

So flooding is still an issue that's seen to be problematic because it has a domino effect that can create another issue to roads functionality. Not only impact towards traffic flow, but indirect on production and livelihoods. Due to poor drainage, flooding can occur by the capacity of drainage that cant hold a large volume of water when rainfall (Zhu Jingxuan et al, 2018). So not only cause lossed of life and

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property, but it can deteriorate functions of critical activities in the city [10]. So by this, it's crucial to have this problem fixed and reconstructed right away [28] [29] [30].

3. Methodology

Data is one of the most significant elements of scientific research. Data will make the research outcome more accurate [7] [10]. The scientific research process must be started by identifying the societal issue. These problems can give relevant data through research (Rifai A.I et al, 2016). The research can determine all types of various methods, which is the most suitable to collect and interpret the data in the research for the answer [8] [9].

Descriptive research selection aims to gather data at random, create descriptions, evaluate current issues in detail, and factually consider the facts gathered. This research uses qualitative methods to collect the data. Using this method, it will help to bring a better understanding of the collected data. This study investigated the effects influencing roadway drainage systems. The study focuses on what triggers the poor drainage system that can cause damage to the road surface and transportation. This research uses qualitative methods to collect the data. Using this method will help to find the trigger of an inadequate drainage system and the effects on the road pavements. The sampling is based on Nagoya by surveying the drainage channels that can be seen in Figure 1.

Figure 1. Location survey of the drainage

Using this method in the Nagoya location will be able to support this study because in Nagoya area is the one that suffers the most flooding after heavy rainfall. The study area traffic and road conditions are a complex mix of heavy traffic and inadequate drainage. So, this is perfect for the survey location to analyze the trigger. So the data will be collected by survey and analyze environmental factors. .Afterward, the data on road damages and drainage systems will be based on survey result.

4. Result and Discussion

4.1 Drainage Factors

Floods can occur in several densely populated areas, including Batam City sub-district Nagoya. This can happen because of intense rainfall, Nagoya area is densely populated but the quantity of existing drainage is adequate; however, their performance could be better. But the problem still cannot be solved due to Nagoya's frequent floods throughout the year. Factors that cause Nagoya's drainage performance poor are garbage and sedimentation which can be seen in Figure 2.

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Figure 2 Nagoya Drainage conditions with garbage and Sedimentation

To those 2 factors, heavy rain falls, the water will overflow due to the drainage being shallow and decreasing water flow by sedimentation by soil or sand and buildup garbage that can be seen in picture 5 and road damages such as potholes, puddles, and cracks due to submerged for an extended period that can be seen in picture 6. Although road planning must be aware of intense rainfall, the surface pavement layer can get critical damage because it doesn't have any traits against water flood (Rifai A.I et al, 2023). Based on this, the Batam Nagoya drainage system is creating a domino effect from people loosening people's daily activity, forcing reroutes on transport, road surfaces getting covered in flood, extreme traffic congestion, and a high risk of accidents. So, it's necessary to have planning reconstruct the drainage system to upgrade drain system performance to overcome flood disasters and minimalized road pavement damages that can reduce congestion.

Figure 3. Drainage and submerged by flood

Therefore, this type of condition for drainage system and road pavements need to follow outside-country method, such as Australian drainage system, like Installing a net to trap the drainpipe. This system only consists of big nets that are placed on the drainpipes. Those pipes will drain the water to the canal, and garbage that gets drifted by the water flow will be trapped onto the net, as seen in Figure 4. For sedimentation, sediment traps can be installed through the drainage base. Along a deep pool within a waterway, the water flows slowly and significantly, allowing the particles of sand, soil, and mud to drop out of suspension and sink to the bottom of the trap which can be seen in Figure 4.

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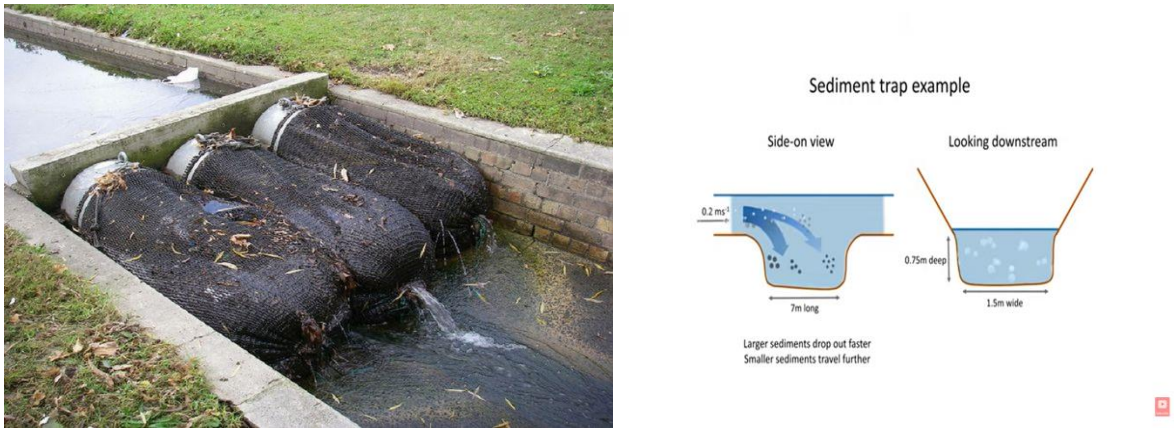

Figure 4. Net trap to increase drainage water flow and Prototype sediment traps

5. Conclusion

This research was conducted at Batam, sub-district Nagoya, on May 20, 2023. This research has been reviewed show that the drainage system performance is systematically poor. The drainage can hold a large volume of water due to the buildup of garbage and sediments. So, the water flow will be decreased and overflow, flood the road pavements, and damage the surface pavement, causing cracks and potholes. So, using a Net trap and sediment trap to the drainage pipe and base can increase the flow and reduce the overflow so that the road pavements are not damaged by flood water.

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