Application Of Pervious Concrete as An Alternative Road to Mitigate Flooding in Don Honorio Ventura State University (DHVSU) Main Bacolor, Pampanga

Hasley Nichole S. Mejia [1], Cyrill Jay C. Buhisan [1], Angela Bea D. Cayanan [1], Gian Audrey L. Lacson [1], Adrian N. Mandapat [1], Rosemawattee R. Sasot [1], Lance Lenard L. Tungol [1], Raul O. Duya [1], Charles G. Lim [1]

[1]*Student, College of Engineering and Architecture, Department of Civil Engineering, Don Honorio Ventura State University, Cabambangan, Bacolor, Pampanga, Philippines.*

Corresponding Author: hasleynicholemejia@gmail.com

Abstract: - Flood is the overflowing of water onto the land that has an impact on how effectively pavements are used. The majority of pavements are constructed with impermeable surface layers to stop natural water infiltration into the soil layer, which can increase the risk of flooding on the pavements. One of the potential remedies that could assist reduce the flood is the use of pervious concrete, due to its permeable characteristics that allow water to infiltrate the pervious concrete for the water to reach the soil layer. Studies have shown that pervious concrete's compressive strength is lower than that of ordinary concrete pavement due to its permeability properties; as a result, applications of pervious concrete are currently restricted to low- or no-traffic regions. Urban areas are suitable for the application of pervious concrete due to their low or no-traffic areas. Don Honorio Ventura State University (DHVSU) is considered an urban area based on the requirements it fulfilled to the Philippines Statistics Authority (PSA). The researcher conducts their study inside the university to know its applicability to the university's pavement. In producing a test sample, the researchers used 3 types of mixture, 2 types of aggregate size, 2 types of aggregate shapes and then it needed to undergo 3 types of tests which is the compressive strength, permeability, and abrasion resistance test. Data collection is performed inside the university for the data or information needed for the research study. The data is examined using graphs and tables to demonstrate the impacts of shape, size, and the water-to-cement ratio on compressive strength, permeability, and abrasion resistance tests once data collection and test results have been obtained. In addition, the study came to some important conclusions about the applicability of pervious concrete pavement, the identification of solutions to unsolved problems, and recommendations about the influence of pervious concrete pavement on the efficiency of pavement use.

Key Words: — ***Pervious Concrete, Permeability, Abrasion Resistance, University.***

I. INTRODUCTION

Flood is one of the natural disasters encountered by different nations.

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Heavy rainfall and tropical cyclones cause overflowing water which destroys things on its path. The most harmful characteristic of flood is its duration or capability to stay for a long time. Several studies were conducted by experts which aimed to find solutions in order to eliminate or mitigate the potential damage of floods. There are countries which utilized those solutions and modified them to suit their needs. Before implementing a solution, careful research must be done since the method which must be used varies on the concern and unique situation of each nation. Mostly, roads are one of the most affected areas when flood arise.

Pavements are utilized every day for highways, airport runways, parking lots, and driveways. It is a durable hard surface installed on a surface meant to support the weight of a vehicle or foot activity. Floods can significantly affect the use of pavements. According to Pregnolato, M., et al., (2017), intense precipitation is one of the reasons why floods occur, particularly events like flash floods which start rapidly. The main reason for weather-related disruptions to the transportation industry, which are projected to continue in the future, is intense precipitation. This is a serious problem on road networks in urban areas such as towns and cities. There is a specific method that other nations used in response to their flooding problem. It is known as the pervious concrete pavement which is specifically used in roads. Pervious concrete (PC) is comparable to Portland cement concrete, in which both materials consist of similar types of ingredients used. However, stormwater can quickly permeate a porous medium due to pervious concrete's lack of fine aggregate and open-graded coarse aggregate. Also, PC is beneficial for removing pollutants from runoff and minimizing the heat island effect (AlShareedah, O., et al., 2019). In Japan, urban areas become flooded due to heavy rainfall and the majority of urban pavement is built with impervious surface layers like dense asphalt pavement and sidewalks. The Public Works Research Institute developed a simulation technique that illustrates the runoff amount procedure when the permeable pavement is used. The findings indicated that, when used in urban areas, permeable pavement could prevent flooding entirely or at least significantly reduce it (Nakanishi, H., et al., 2020).

One of the well-known nations which regularly experience flood is the Philippines. This is because of its geographic location. It is positioned in the heart of the typhoon belt right at the intersection of several large tectonic plates (IvyPanda. 2023). In many areas of the Philippines, flooding became an accustomed experience for the locals. Pervious concrete pavement is a potential solution to the flooding issue because most pavements are composed of concrete and asphalt. By preventing runoff from naturally penetrating the soil, these increase the risk of flooding in some places. Pervious concrete applications are now restricted to low- or no-traffic areas due to studies showing that it has high permeability properties and lower compressive strength than conventional concrete pavement (Bonicelli, A., et al., 2016). There are guidelines in considering a place as an urban area. Philippines Statistics Authority (PSA) considers a city/municipality as urban if its population is at least 5,000. Therefore, a municipality such as Bacolor is an urban area since its population is 48, 066. This is based on the 2020 census, which means areas within Bacolor are considered urban areas. Moreso, the data implies that DHVSU is categorized as urban area.

Flood pertains to the rising and overflowing of a body of water. Don Honorio Ventura State University (DHVSU) is prone to this whenever there is a strong typhoon or rain. When the roads or runways are flooded, it affects most of the area in the university, and it takes over a week for the flood to be drained. To fasten the depletion of floods in the university, the researchers conducted a study inside the university to be able to mitigate the occurrence of a flood which will benefit or improve the university. Pervious concrete is not commonly used in the Philippines, but foreign government-sponsored innovative pavement material such as pervious concrete because of its permeability and environmental benefits. Based on its advantages and disadvantages, pervious concrete pavement has high potential effectiveness if applied to urban areas which correspond to low traffic volume and flood-prone areas. In view of the situation, if concrete pavement will be replaced with pervious concrete as a primary material in road construction, the flooding problem they experience will be lessened. Hypothetically, pervious concrete may significantly help the Philippines as well as universities like Don Honorio Ventura State University.

II. METHODOLOGY

The product's strength, permeability, and abrasion resistance were tested as part of experimental study, which falls under quantitative research. A variety of approaches are used in quantitative research, which is focused with employing statistical or numerical data to methodically analyze social issues. Quantitative research is measurement-based as a result of this reliance on measurements and the assumption that the phenomena being studied can be quantified. While searching for patterns and correlations in the data, it aims to validate the measurements (Watson, 2015).

The study was conducted at Don Honorio Ventura State University-Main commonly known as DHVSU. DHVSU is prone to whenever there is a strong typhoon or rain. When the roads or runways are flooded, it affects most of the area in the university, and it takes over a week for the flood to be drained.

It is located at Bacolor Pampanga, Philippines, and is known as the oldest vocational school in Far East Asia.

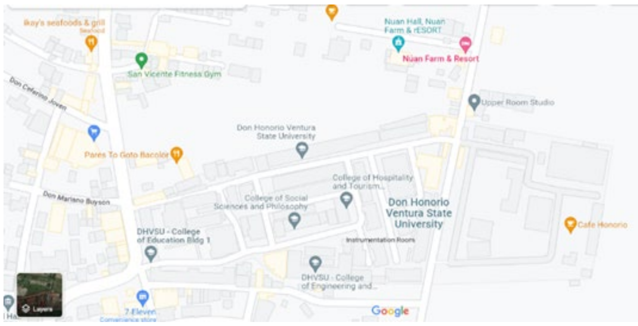

Fig.1. Map of Don Honorio Ventura State University, Bacolor Pampanga

Source: Google, (2023). Google My Maps [Web application].

In Figure 2, the pervious concrete layering or components are identified namely the pervious concrete layer and the G1 rock layer. Moreover, other materials or design are also indicated for pervious pavement, and this are the perforated pipe and pipe valve. The purpose of pervious concrete layer is for the flood or runoff above the surface of the road is to penetrate through the later going on the 2nd destination which is the G1 rock layer that act as semi container for the excess water. In the G1 rock layer wherein perforated pipe is located and its function is to guide the excess water through the drainage. The flood water that are not directed at the drainage will continue to pass the G1 rock layer wherein the soil layer will do its job to absorb the excess flood water.

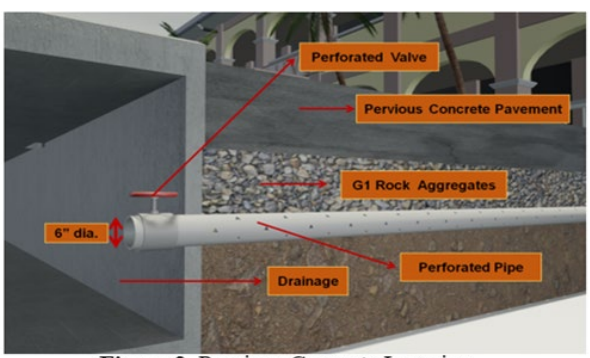

Figure 2. Pervious Concrete Layering

According to the Department of Public Works and Highways (DPWH) classification of roads, the cross section of the pervious concrete pavement design is shown in Figure 3. The width of the two-way pavement is 6.10 meters, and the length of the perforated pipe that is positioned along the aggregate layer is 6.4 meters. For the thickness of pervious concrete layer 0.15m is used and for the G1 rock aggregates the thickness is 0.30m based on suggested thickness according to ACI 2010.

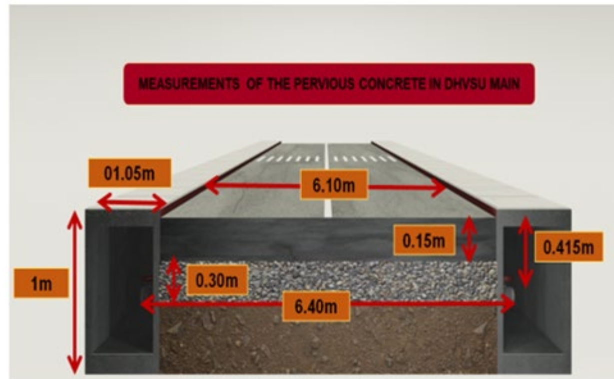

Figure 3. Cross Section of Pervious Concrete Pavement

The researchers used different gathered data. These include the DHVSU blueprint, historical information about flooding in Cabambangan, the Bacolor hazard map, and several laboratory tests that will guarantee the strength, permeability, and abrasion resistance of the suggested pervious concrete pavement. The compressive strength test (ASTM Standard Test Method C39 for Compressive Strength of Cylindrical Concrete Specimens) and constant head method (ASTM D2434) will be used to evaluate the pavement's strength and permeability, respectively. The weight loss of the specimen when a moving load is applied on dry sandpaper served as a measure of the concrete samples' abrasion resistance.

2.1 Specification

2.1.1 Aggregate size and shape

One crucial factor which affects pervious concrete mixture's quality is the aggregate size. In this experiment, single-sized coarse aggregates of 9.5 mm and 19 mm were used. Only angular shape aggregates and rounded shape aggregates were taken into consideration because ACI (2010) discouraged the inclusion of flaky and elongated particles in the combination. It is also important to note that the only type of aggregate used was coarse aggregate. While ACI (2010) allows for a modest amount of fine aggregate to be used in concrete, doing so may reduce the permeability of the concrete mixture by interfering with the interconnectivity of the pore system.

2.1.2 Cement

This refers to a powdered material that contains a smooth texture and gray in color type 1P cement. There were two types of cement: Type 1 pure Portland cement, and Type 1P - cement containing additives or pozzolans.

2.1.3 Water-to-Cement Ratio/ w/c

The w/c ratio for standard concrete typically ranges from 0.40 to 0.60. However, this cannot be the case for pervious concrete because in this type of concrete, "an excess amount of water leads to drainage of the paste and subsequent clogging of the pore system" (ACI, 2010).

2.1.4 Mixture Proportioning

The main constituents that made up the pervious concrete specimens are cement, coarse aggregates, and water. Since there is no specific standard in determining the mixture proportions of a pervious concrete mixture yet, the researchers used an existing mixture for pervious concrete. Cement and Aggregate: 1:4, 1:5, and 1:7 with a water-to-cement ratio of 0.40.

Finally, combinations of the test cases for the pervious concrete specimens are summarized in Table 1.1-1.3

Table 1.1 Test Cases for the Pervious Concrete Mixture

Test Case (Cement: Aggregate)	Aggregate Shape	Aggregate Size	W/c Ratio
1:4			
1:5	Angular	9.5 mm (3/8)	0.40
1:7			

Table 1.2 Test Cases for the Pervious Concrete Mixture

Test Case (Cement: Aggregate)	Aggregate Shape	Aggregate Size	W/c Ratio
1:4			
1:5	Rounded	19 mm (3/4)	0.40
1:7			

Table 1.3 Test Cases for the Pervious Concrete Mixture

Test Case (Cement: Aggregate)	Aggregate Shape	Aggregate Size	W/c Ratio
1:4			
1:5	Angular	19 mm (3/4)	0.40
1:7			

2.2 Data Collection

2.2.1 Compressive Strength

Data on the compressive strength of the pervious concrete samples were gathered using ASTM C39/C39M, or the Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. The images in Figure 4 show the pervious concrete samples that were used in the test. These samples measure 300 mm in height and 150 mm in diameter. The examples were allowed to cure for 15 and 29 days, respectively, which is longer than the typical 14 and 28 days for curing conventional concrete because pervious concrete typically needs more time to cure. The setup during the compressive strength test is shown in Figure 5.

Fig.4. Pervious Concrete Specimen

Fig.5. Compressive Strength Test Set-up

2.2.2 Permeability

The Constant Head Test, one of the standard techniques employed by numerous research about pervious concrete, was utilized to ascertain the permeability rates of the pervious concrete samples. While the Falling Head Test can also be used, ACI (2010) emphasizes that results obtained from these two methods agree reasonably with each other. The setup used is shown in Figure 6. The head difference was kept at a constant value of 100 mm. The volume of water that flowed through the concrete sample for 60 seconds (one minute) was collected and substituted to Equation 1 to obtain the permeability rate.

Equation 1

$$\boldsymbol{k = \frac{LV}{tAh}}$$

where:

k = permeability (mm/s)

L = length of concrete sample (mm)

V = volume of water collected (mm^3)

t = time to collect the water (s)

A = cross-sectional area of the concrete sample (mm^2)

h = constant head difference (mm)

Fig.6. Constant Head Permeability Test Set-up

2.2.3 Abrasion Resistance

The setup shown in Figure 7a is used to determine the lost weight after the application of the dynamic loading. The setup in Figure 7b was designed to emulate the movement of a wheel on a road surface as shown in Figure 7a. The sandpaper attached to a wood represents the surface of a wheel, and the 5-kg load acts as the weight of the wheel itself. This load was selected so that the concrete mixture only acts as a part of the low-traffic pavements. For five minutes, the surface of the pervious concrete samples was sanded with a combination of silicon carbide sandpaper and wood. The specimens, which had dimensions of 150 mm 150 mm 550 mm, like the one in Figure 8, were weighed before and after the abrasion test, and the results were then entered into Equation 2 to determine the percentage weight loss as a result of abrasion. The test was conducted 29 days following the cure.

Equation 2

$$\boldsymbol{\Delta W = \frac{W_2 - W_1}{W_1}\, x\, 100\%}$$

where:

$\boldsymbol{\Delta W}$ =percent weight loss due to abrasion (%)

$\boldsymbol{W_1}$ = initial weight of the concrete sample (kg)

$\boldsymbol{W_2}$ = final weight of the concrete sample (kg)

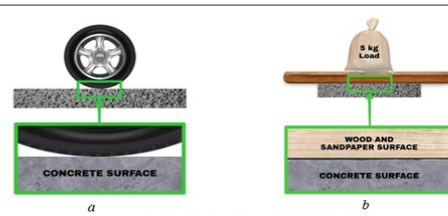

Figure 7. Abrasion Resistance Test Set-up

Figure 8. Example of the sample used for Abrasion Resistance Test

2.2.4 Flood Mitigation

The calculation and formula used to calculate the efficacy of pervious concrete pavement in flood control were taken from Geotechnical Engineering (Revised Third Edition) by C. (2012) Venkatramaiah. The mentioned formula indicates that, Darcy's law formula or equation are used to obtain the value of time it takes for the pervious concrete pavement to mitigate flooding in the flood prone areas of DHVSU.

Equation 3

$$q = kiA; \qquad q = \frac{V}{t}$$

Where:

- **q** = Flow rate
- **k** = Hydraulic conductivity (permeability coefficient)
- **i** = Hydraulic gradient
- **A**= Area of the flow path's cross-section.
- **t** = Time taken
- **V**= Volume

After data on the compressive strength, permeability, and abrasion resistance of the pervious concrete specimens were gathered, bar graphs were utilized to demonstrate how values for these attributes alter with varied ratios, aggregate shapes, aggregate sizes, and w/c ratios. All of the graphical displays were produced using the program Microsoft Excel.

The aggregate form and size that would produce a concrete sample with adequate compressive strength and permeability within the 1.35 mm/s minimum requirement set out by the ACI were determined using bar graphs.

III. Results and Discussion

3.1 Effects of the Variables on Pervious Concrete's Compressive Strength

The permeability rates of the samples of pervious concrete were commonly found to be in the range of 4.95 mm/s to 8.63 mm/s, as indicated in Table 2. According to the data, permeability of at least 1.35 mm/s is within the range indicated by ACI's Report on Pervious Concrete from 2010.

The average compressive strengths of each sample examined are shown in Table 2. The results are expectedly lower in comparison to conventional concrete. A compressive strength of 14.71 MPa was achieved, which is adequate for most low-volume pavement applications such as pedestrian paths or sidewalks, which require at least 13.05 MPa (Septiandini et al., 2021).

Table.2. Summary of the Compressive Strength, Permeability, and Abrasion Resistance of the Pervious Concrete Samples

Test Case	Aggregate Shape	Aggregate Size	Ratio	Compressive Strength (MPa)			Average Permeability (mm/s)	Average Percent Weight Loss due to Abrasion (%)
				7 days	15 days	29 days		
1	Angular	9.5	1:4	5.52	7.06	6.78	5.80	0.117
2		9.5	1:5	3.97	3.82	5.10	6.08	0.196
3		9.5	1:7	1.74	1.90	3.40	5.66	0.392
4		19	1:4	-	9.34	12.52	4.95	0.075
5		19	1:5	-	4.96	3.28	6.79	0.078
6		19	1:7	-	4.18	5.63	6.22	0.041
7	Rounded	19	1:4	-	2.51	3.82	6.51	0.075
8		19	1:5	-	10.21	7.34	7.36	0.037
9		19	1:7	-	7.70	14.71	8.63	0.033

3.2 Effects of Aggregate Shape

The pervious concrete sample that was cured for 29 days got higher results than the samples with 15 days of curing. The researchers used two types of shapes of aggregates with the pervious concrete samples: Angular and Rounded Aggregates. Based on the conducted research, the rounded aggregates have higher compressive strength of 14.71MPa, permeability rate of 8.63 mm/s and abrasion resistance of 0.033% than the angular shape aggregates. In terms of aggregate size its effect shows that 19mm aggregate have higher compressive strength, permeability and abrasion resistance than the 9.5mm aggregate, which means the bigger the size of the aggregate will produce higher result based on the conducted test.

The pervious concrete sample of a rounded aggregate of 1:7 ratio at 29 days of curing got the highest results in the compressive strength and the angular aggregate of 1:4 ratio at 29 days of curing got the second highest result. Note that the researchers used improvised materials that may alter the results.

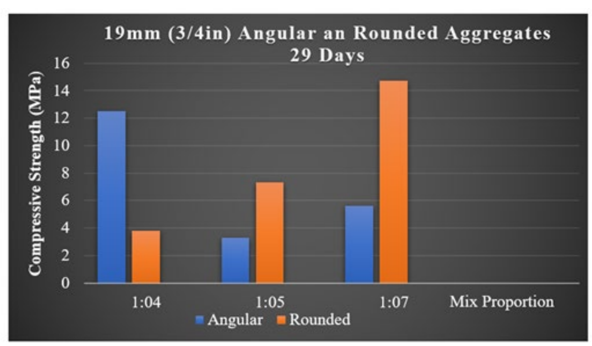

Fig.9a. Effects of Aggregate Shape to Compressive Strength of Pervious Concrete Sample

Figure 9b shows the relationship of the shape to the permeability of the aggregate. The rounded aggregates have higher permeability rates compared to the angular aggregates. Although the difference in the permeability rates between the two is much closer than the difference in compressive strengths, the high values for rounded aggregates can be attributed to their physical characteristic. With irregularity in the shapes of the angular aggregates, it covers the voids thus not allowing the water to flow smoothly. The 19mm rounded aggregate got the highest permeability result which is 8.63mm/s. The least permeable among the concrete samples is the 19mm angular pervious concrete sample which is 4.95mm/s. The permeability test revealed that the water passes smoothly in the rounded aggregates compared to the angular aggregates.

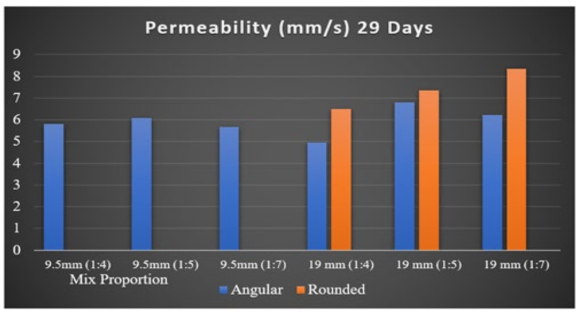

Fig.9b. Effects of Aggregate Shape to Permeability Rate of Pervious Concrete Sample

Figure 9c displays the weight loss percentage caused by the abrasion test on samples of pervious concrete. As shown in the figure, the angular aggregates have a higher percentage of wear in the abrasion test compared to the rounded aggregates. This may be related to the feature of angular aggregate which has a higher specific surface area. The rounded aggregate got the lowest percent weight loss.

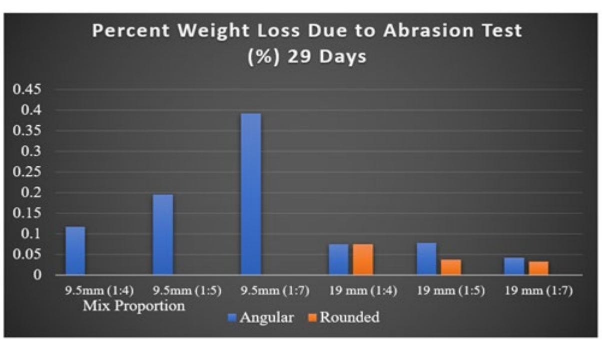

Fig.9c. Effects of Aggregate Shape to Abrasion Resistance of Pervious Concrete Sample

3.3 Effects of Aggregate Size

The compressive strength of the pervious concrete samples is significantly impacted by the size variation of the particles. Figure 10a, which is based on the graph, demonstrates that samples using 19 mm had greater compressive strengths than samples using 9.5 mm after 15 days of curing. Additionally, the samples that have been cured for 29 days are shown in Figure 10b.

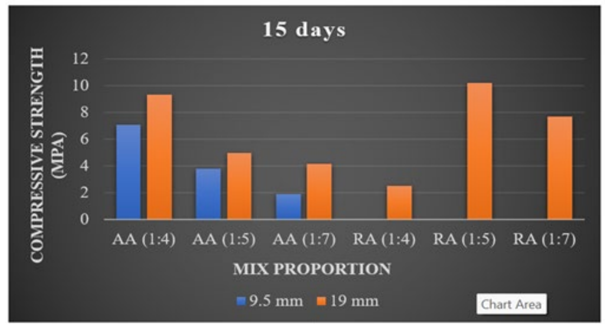

Fig.10a. Effects of Aggregate Size to the Compressive Strength of Pervious Concrete Sample (15 days).

According to the results, samples with aggregates of 19 mm tend to be stronger in compressive force resistance than samples with aggregates of 9.5 mm. Since the researchers apply the same amount of water and cement to each sample, the only factor that will differ across samples will be the amount of aggregates used, the sample combination has a considerable impact on the outcomes. Furthermore, the larger and smaller aggregates are equally weighed, making larger aggregates have better water and cement combination on their mixtures to cover more voids and bond the aggregates stronger compared to the smaller aggregates that lack cement as their binding material.

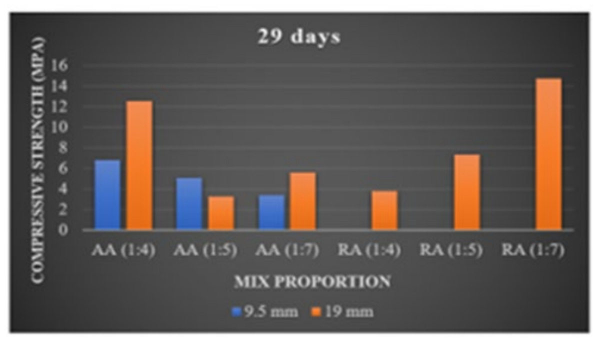

Figure 10b. Effects of Aggregate Size to the Compressive Strength of Pervious Concrete Sample (29 days).

Contrary to this, Figure 10c findings revealed that mixtures with aggregates of 19 mm are likely to have higher permeability rates than the combinations with aggregates of 9.5 mm. It can be explained by the fact that larger voids compared to smaller voids permit the water to pass through more freely. Additionally, the permeability of angular aggregate samples made with 9.5 mm aggregates ranges from 5.6 mm/s to 6.08mm/s. While samples with a 19 mm inner diameter have higher permeability rates because of larger voids, ranging from 4.95mm/s to 6.79 mm/s. The round aggregate samples of 19 mm vary from 6.51 mm/s to 8.63 mm/s at the same time. Furthermore, round aggregates of 19 mm show the highest permeability rates of all samples, The samples in these circumstances met the minimum Permeability Rate required by ACI. All the samples are above 1.35 mm/s.

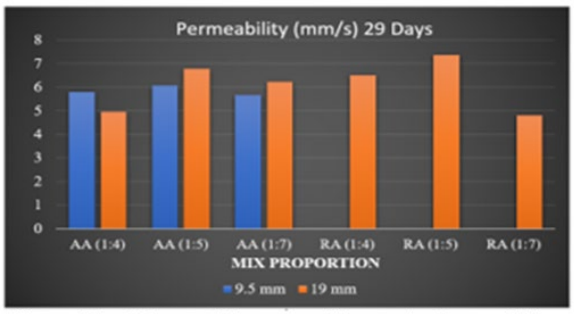

Figure 10c. Effects of Aggregate Size to the Permeability Rate of Pervious Concrete Sample

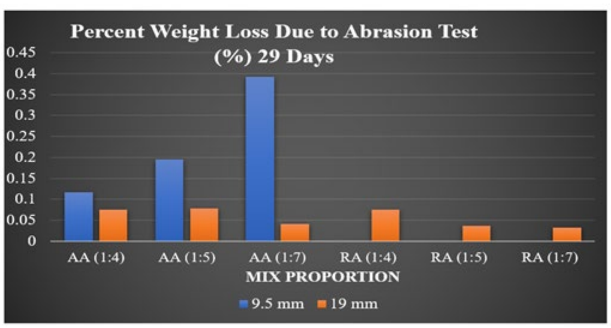

Fig.10d. Effects of Aggregate Size to the Abrasion Resistance of Pervious Concrete Sample

Figure 10d shows that the abrasion resistance of the pervious material has not changed much. 9.5 mm and 19 mm coarse particles were used to create concrete samples. However, on three of the three occasions in Angular aggregates, the 9.5 mm samples scored marginally higher than the 19 mm samples, indicating that they exhibit lower abrasion resistance. Due to the size and weights of the aggregates as they are a lot less difficult to move to compare them to the larger aggregates when there is load acting upon them. There is no comparison in rounded aggregates.

3.4 Effects of Water-to-Cement Ratio

Figure 11 shows how the pervious concrete's permeability rate drops as the w/c ratio increases. Since the lowest permeability rate, 4.95 mm/s, was recorded on the pervious concrete samples built with 9.5 mm angular aggregates, an increase in the w/c ratio could cause the samples to fall short of the minimum permeability rate of 1.35 mm/s mandated by the ACI. The maximum permeability rate, 8.63 mm/s, was achieved by rounded aggregates with a 19 mm dimension.

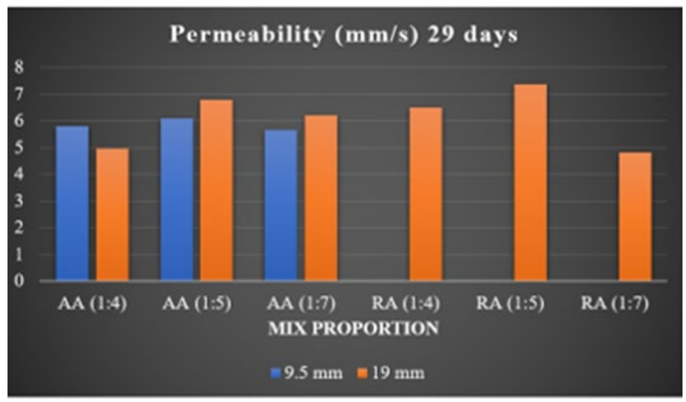

Fig.11. Effects of Water-to-Cement Ratio to the Permeability Rate of Pervious Concrete Sample

All materials in rounded and angular have the same measurement used in bonding materials. Rounded aggregates do not fill all the voids that cause water to penetrate more than usual while angular aggregates have different shapes that can fill the voids and causes water to slowly penetrate.

3.5 Effect of Pervious concrete pavement in terms of time to mitigate flooding in DHVSU

Table 3. Types of Layer

Sample ID.	Types of Layer
1	Pervious Concrete
A	Clay Soil
B	Loam Soil
C	Sandy Soil

The actual type of soil in DHVSU Main is not identified due to the lack of time to conduct a test. In this study 3 different types of soil are used to provide data to satisfy the absence of specific type of soil in DHVSU Main. The different types of soil used are shown in Table 3 which are clay, loam, and sandy soil. The time it takes for the soil layer to absorb the storm water is needed to identify the total time it takes for the pervious concrete pavement design in mitigating the flood in DHVSU Main.

Table 4. Summary of data for the Computation of Time

Sample ID.	Hydraulic conductivity (cm/s)	Cross-section area (cm^2)	Flow rate (cm^3/s)	Volume (cm^3)	Time (sec)
1	0.863	27.120x10^6	31.803x10^6	969.540x10^6	30.49
A	0.000177	27.120x10^6	10344.5172	969.540x10^6	93725.0121
B	0.001412	27.120x10^6	82522.3632	969.540x10^6	11748.5221
C	0.002824	27.120x10^6	165044.7264	969.540x10^6	5874.4076

The data obtained from the computations are shown in Table 4. The volume is the amount of flood in DHVSU Main determined based on the secondary data which are documentation or actual images that shows the level of flooding in DHVSU Main. The time taken for the flood to flow or pass through the permeable layer which is the pervious concrete is 30.49sec. After the flood water passes through the permeable layer the soil layer will absorb the water to help mitigate the flood wherein the time taken for the soil layer to absorb the water is identified.

Table 4.1. Summary of date and Percentage Computation

Sample ID.	Time, T_1 (hr)	Time, T_2 (hr)	Formula	Percentage (100-P) %
1.A	26.04	336	$P = \frac{T_2 - T_1}{T_2} x\ 100$	92.25
1.B	3.27	336		99.03
1.C	1.64	336		99.50
			Total Average	**96.93**

In Table 4.1 the time it takes for the water to pass through pervious layer which is 30.49 sec is added to the value of time of sample ID A, B and C that changes into sample ID 1.A-B-C wherein the unit of time is converted into hour. For the clay soil the time taken for the soil to absorb the water is 26.04 hours, next is the loam soil that takes 3.27 hours, lastly as for the sandy soil the time taken for the soil layer to absorb the flood water is 1.64 hours.

According to DHVSU Main OPPF the recorded amount of time for the flood to dissipate in DHVSU Main is 2 weeks which is 336 hrs. In determining the percentage, the amount of time (hrs) taken for the pervious pavement design is divided by 336 hrs then multiply by 100. The Pervious concrete pavement shows impressive results wherein the highest percentage in mitigating the flood is 99.50% faster than the 336 hrs common duration of flooding in DHVSU. Even the lowest percentage shows great result which is 92.25% and the total average of the effectiveness of the pavement design in terms of flood mitigation is 96.93%. It concludes that the different types of soil have no make major effect or impact in the effectiveness of pervious concrete pavement design.

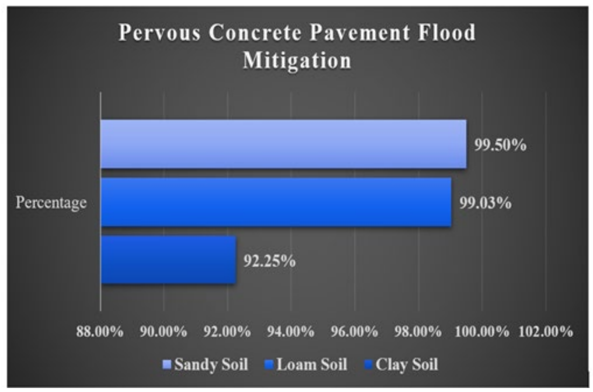

Fig.12. Effect of Pervious concrete pavement in flood mitigation of DHVSU

IV. Summary, Conclusions And Recommendations

This chapter presents the summary, conclusion and recommendation of the study.

4.1 Summary

The study's findings are as follows:

- Type 1P - cement containing additives or pozzolans is a good binding material for making pervious concrete.
- Pervious concrete compressive strength is not as strong as traditional concrete.
- The pervious concrete samples' permeability rates were discovered to be within the range of the anticipated permeability of at least 1.35 mm/s. between 4.95 mm/s to 8.63 mm/s.
- When employing 19mm rounded particles, the pervious concrete mixture has the best compressive strength without sacrificing its permeability with a mix ratio of 1:7 and a w/c ratio of 0.40.

4.2 Conclusions

The study discovered that rounded aggregates will produce pervious concrete a greater compressive strength, tolerable permeability, and superior abrasion resistance when compared to angular particles. Additionally, it has been found that although while the test results are still significantly higher than the permitted permeability of 1.35 mm/s, as the aggregate size used for the coarse aggregates gets larger, the compressive strength increases and the permeability also increases. The w/c ratio has the most consistent, substantial effect on the permeability of pervious concrete, according to the study. In terms of the effectiveness of pervious concrete pavement in mitigating the flood in Don Honorio Ventura State University (DHVSU), the study concluded that the application of pervious pavement is effective in mitigating the flood in DHVSU wherein the average percentage on how fast flood mitigate with the application of pervious concrete pavement is 96.93%.

Furthermore, low-traffic surface applications like walkways or pedestrian paths can employ this concrete. Additional ASTM-compliant testing must be carried out.

4.3 Recommendations

- The study should consider the availability of the 9.5mm rounded aggregates.
- The recommended bonding material to use is Type 1 Pure Portland cement since it sets up faster than other bonding products on the market.
- Type 1P cement containing additives or pozzolans is also recommended or can be used as an alternative just in case type 1 Portland cement is not available as it also has the same function as type 1 Pure Portland cement.
- Due to how much longer type 1T takes to bond than type 1 Pure Portland and type 1P, type 1T is not advised for use.
- It is recommended to carry out another similar one to further validate the findings. Considerable variations in the results acquired throughout the testing may have been caused by factors such as temperature control, the use of potable water, and concrete handling.
- It is also recommended to test pervious concrete used as pavement for things like split tensile strength, flexural strength, toughness, acoustic absorption, market viability, and life cycle analysis.
- Another recommendation is the use of other types of pervious pavement such as porous asphalt wherein this type of permeable pavement provide smooth and uniform road surface that can enhance the appearance of a site.
- Conduct a cost benefit ratio to support the application of pervious concrete as an alternative pavement in DHVSU.
- It is recommended to carry out more study on how to improve the compressive strength of pervious concrete using ratio or other strengthening materials or components.

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