

# IJCIET

## INTERNATIONAL JOURNAL OF CIVIL ENGINEERING AND TECHNOLOGY



Journal ID: 6971-8185



ACADEMIA



**IAEME Publication**

Chennai, India

editor@iaeme.com/ iaemedu@gmail.com



<https://iaeme.com/Home/journal/IJCIET>



# IMPROVING THE PHYSICO-MECHANICAL PERFORMANCE OF LIGHTWEIGHT CONCRETES WITH POLYSTYRENE IN CAMEROON

**Nie Noumsi Thierry Constant (PHD Eng.)**

Fotso Victor University Institute of Technology, Civil Engineering Department, Research Unit of Industrial Systems and Engineering Environment (UR-ISIE), University of Dschang, Cameroon.

**Kayimbo Kamga Cyrill (MSc)**

Fotso Victor University Institute of Technology, Civil Engineering Department, Research Unit of Industrial Systems and Engineering Environment (UR-ISIE), University of Dschang, Cameroon.

**Bakam Stela (MSc)**

Fotso Victor University Institute of Technology, Civil Engineering Department, Research Unit of Industrial Systems and Engineering Environment (UR-ISIE), University of Dschang, Cameroon.

**Pelap Francois beceau (Professor)**

Faculty of Science, Department of Physic, Research Unit of Mechanical and Modeling of physic system (UR-2MSP), University of Dschang, Cameroon.

## ABSTRACT

*The population explosion in developing countries, along with uncontrolled and rapid urbanization, fosters a grow demand for housing and a significant increase in waste production. The objectives of this study is to defined a polystyrene-based concrete*

*formulation that exhibits appropriate physical and mechanical properties for construction. For this study, expanded polystyrene was used in the manufacture of the concrete. The Dreux – Gorisse formulation method was applied, which combined several mix design approaches (Faury Bolomey, CES), and takes into account the characteristic of the materials selected for a specific project. Various concrete mixes were proposed, incorporating polystyrene in proportion ranging from 10% to 50%, in steps of 10% and compared to a reference sample. the test specimens use were cubes (10cm x 10cm x 10cm). the result obtained from the analyses of the different sample show that polystyrene concrete has lower compressive strength and density than conventional concrete, but their consistency increase with the addition of polystyrene. However, they may be use for specific type of structures.*

**Keywords:** waste, lightweight concrete, samples, compressive strength

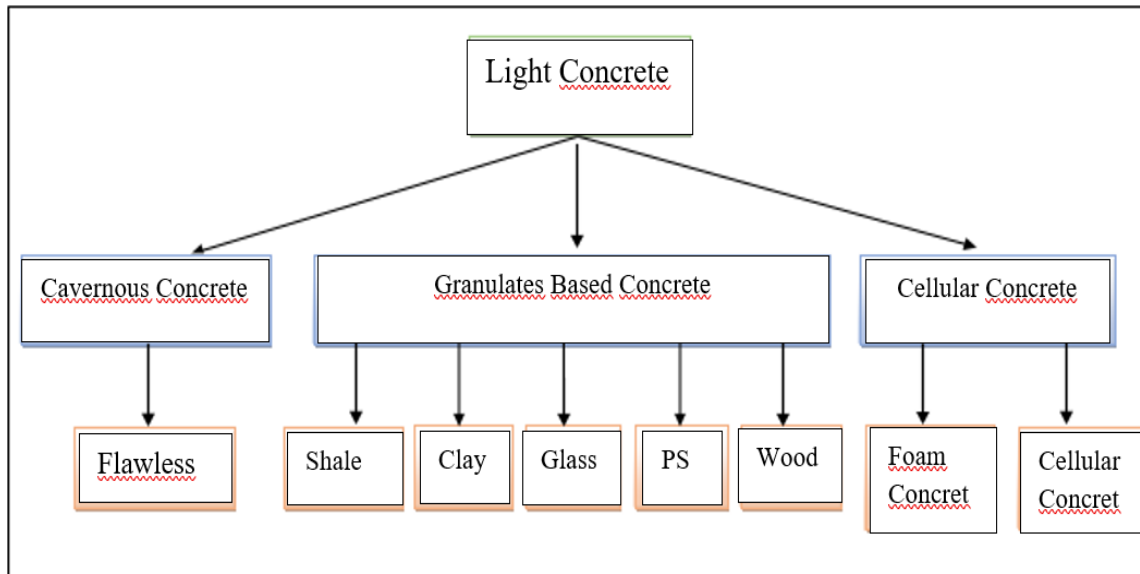
**Cite this Article:** Nie Noumsi Thierry Constant, Kayimbo Kanga Cyrill, Bakam Stela, Pelap Francois beceau. (2025). Improving the Physico-Mechanical Performance of Lightweight Concretes with Polystyrene in Cameroon. *International Journal of Civil Engineering and Technology (IJCIET)*, 16(5), 56-74.

DOI: [https://doi.org/10.34218/IJCIET\\_16\\_05\\_004](https://doi.org/10.34218/IJCIET_16_05_004)

---

## 1. INTRODUCTION

Concrete is one of the most widely used materials in civil engineering. The current challenged is to find substitute for natural aggregate in order to increase the quantities and durability of materials available for construction, protect quarries and rock extraction sites, and reduce greenhouse gas emissions. Numerous studies focus on partial incorporation of non-biodegradable waste (rubber, glass, crushed and powdered hardened cement, straw fibers, bamboo, palm kernel waste, etc.) into concrete to recover and valorize these materials. The research falls within the scope of exploring the feasibility of producing polystyrene-reinforced concrete that meet adequate physical and mechanical properties for specific and durable construction needs. They are three main type of lightweight concrete: cellular concrete, no-fines concrete, and lightweight aggregate concrete.



**Figure 1 :** Types of lightweight concrete

## 2. LITERATURE REVIEW

According to Angnes Zambon (2019), several types of lightweight concrete exist. Lightweight concrete made from natural occurring aggregates that have undergone thermal treatment (such as expanded clay, expanded shales, expanded slate), aggregate form by high gas release within a viscous material, and artificial aggregate derived from industrial waste (such as expanded slag, fly ash, wood chips and sawdust, expanded glass or plastic materials like polystyrene). She wrote a thesis titled “Formulations and physical characterization of lightweight foam concrete based on clay: valorization of sediments”, with the goal of utilizing fine sediments that currently have no effective application. Her study investigates the characteristics of both fresh and hardened concrete using cube molds of 1x1x1 cm<sup>3</sup>. The first parameter considered for characterizing fresh concrete is its density, follow by workability. Result for a BAMS (lightweight concrete with incorporate foam and based on sediments) show that the density of fresh concrete is a function of the water content/liquid limit ratio (w/l), a threshold ratio denoted K\_Threshold, and the cement dosage. Since lightweight concrete contain voids and air, the cement content should be sufficient to fill those voids as much as possible. According to her, using lower density concrete reduces the load on foundations and surrounding structures, improving the overall durability of a structure. Lightweight concrete offered greater flexibility in design, allowing for slimmer building forms. It also helps to reduce overall construction cost by minimizing the size of the structural element, foundation, and the cost of transportation and installation.

Similarly, Sidi Mohammed ZIANI-KERARTI et al. (2020), in their work titled “State on the Art of the Formulation and Behavior of Lightweight Concrete with Expanded Polystyrene Beads”, demonstrate that the use of polystyrene beads offers innovative solution for projects aiming to improve the thermal and acoustic comfort of building envelopes. The concrete formulated with this beads exhibited significantly lower compressive strength compared to traditional concrete. Their study aimed is to compared the test result across different mix designs. Two formulation method were used: The Scramtaiev and the EDILTECO method. They concluded that the scamtiaev’s absolute volume method requires a large quantity of polystyrene for a 1m mix, making it suitable for lightweight concrete containing both gravel and polystyrene. The EDILTECO method produces a well-blended lightweight concrete without the need for gravel. Concrete made with this method is ideal for screed or non-load-bearing structures. Mixing techniques for lightweight concrete vary, particularly in the order of component addition in the mixer. to minimize the loss of lightweight polystyrene beads, they should not be added first. Instead, mixing should begin with cement, sand, and water. Expanded polystyrene beads have a high absorption rate, leading to low slump values and a firmer concrete.

Finally, SENE Licka Khadidiatou et al. (2019) conducted a study on lightweight aggregate concrete with the goal of examining concrete made from expanded clay and seashell in Senegal. Their lightweight concrete formulation replaced the traditional aggregate partially or completely with expanded polystyrene beads to achieve appropriate granular class combinations. This led to a wide range of lightweight concretes with varied densities and strengths. This innovation material, when include in the concrete mixes formed what they refer to as “placo-styrenes” ten times lighter and thirty times more insulating, yet just as strong as traditional concrete. In hot climates, buildings require thermal insulation materials. Expanded polystyrene acts like a climate controlled materials, absorbing excess heat during the day. It provides dry, comfortable spaces and prevent moisture condensation on walls. For their study, specimens of  $4 \times 4 \times 16 \text{ cm}^3$  were used. The 28days compressive strength obtained using the DREUX method averaged 20MPa, which they considered satisfactory, since structural design in Senegal typically requires strengths between 20 and 25MPa, depending on the characteristic of locally available materials (sand, gravel)

### 3. MATERIALS AND METHODS

Since the properties of concrete depends on it composition, we will present the different materials used in the preparation of our concrete, the test performed for their characterization, the mix design process, and the resulting materials properties after casting.

#### 3.1 Field work

This phase involved the acquisition of the various materials according to their origin.

#### 3.2 Materials Used

Several materials were used:

- 0/5 sand
- 5/15 gravel
- Polystyrene
- CPJ CEM II/B 42,5R Cement
- Potable water

#### 3.3 Nature and origin

To promote local materials, all the materials used in this research were sourced locally (Cameroon)

**Table 1:** Nature and origin of materials

MATERIALS	NATURE	ORIGIN	SPECIFICATION
Sable	River/rounded sand	Sanaga (Ebebda – Cameroon)	0 /5
Gravier	Carrière /concassé	Tchipou - Bamoungoum	5 /15
Polystyrène			
Ciment		DANGOTE (Douala – Cameroon)	NC 234 : 3009-6
Eau	Portable water	CDE	Tap water



**Figure 2 :** raw materials required for the study

### 3.4 Laboratory Work

The test on the different materials (sand, gravel, cement) were carry out at the materials and Geotechnics laboratory of the Fotso Victor, University institute of Technology in Bandjoun.

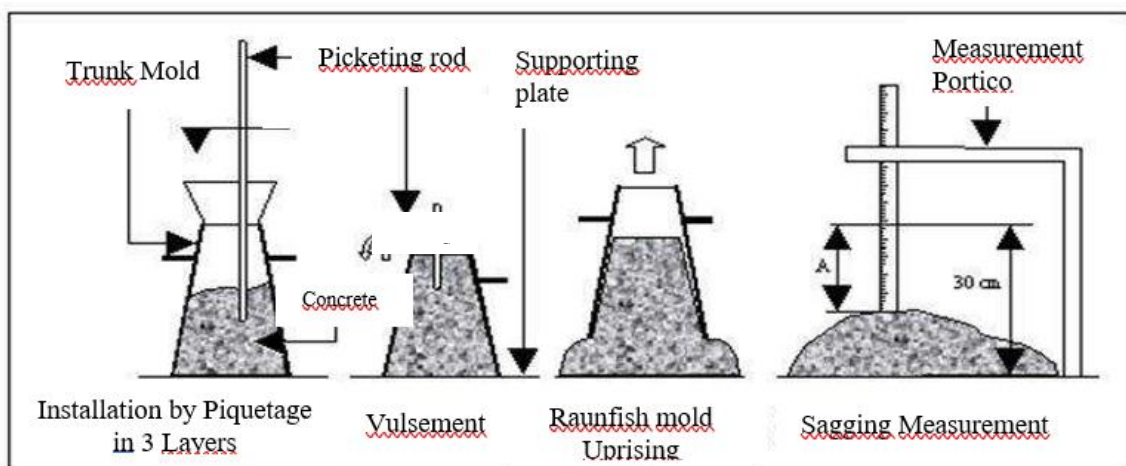
### 3.5 Experimental Methods

This section present the different test perform on the concrete sample after formulation, in order to interpret their physical and mechanical properties in the next chapter.

### 3.6 Workability

The workability (or consistency) of a concrete is commonly assessed using a slump test, also known as the Abrams cone test, on fresh concrete. This test reflects the concrete ability to fill the formwork and properly encase the reinforcement. Once the concrete is prepared, the test is conducted as follows:

- Oil the mold and fix it on a flat and slightly moistened surface
- Fill the mold in three equal layers tamping each with 25 strokes
- Level the surface with the metal rod and clean the surroundings
- Gentle remove the cone; the concrete slump under its own weight depending on it consistency
- Measure the slump value “A” within one minute by reading the height difference between the top of the specimen and the measuring frame.



**Figure 3 :** Slump test using Abrams cone (source: Sidi Mohammed ZIANI 2020).

The valued obtained characterizes the fluidity of the concrete.

**Table 2:** recommended vibration according to concrete workability

Slump	Concrete consistency	Recommended placement method
0 to 2 cm	Very stiff	Powerful vibration
3 to 5 cm	Stiff	Intense vibration
6 to 9 cm	Plastic	Standard vibration
10 to 13 cm	Soft	Tamping
>13 cm	Very soft	Light tamping

### Compressive Strength

Compressive strength is one of the most important properties of hardened concrete. Its consists of applying a compressive load until the specimen fails. The maximum load reach is use to calculate the compressive strength. After preparing the various mixes, they were molded into 10x10x10cm cube, demolded after 24hours, and immerse in water baths to accelerate the maturity. The tests were conducted at 7, 14, 24, 28, and 90 days. The testing procedure is as follow:

- Place the level specimen at the center of the two platen of the compression machine. If the specimen is not leveled, use a replacement device (wooden plates or sand boxes).
- close the safety door and release valve.
- Start the press
- Turn the loading rate valve to maximum until contact is made between the specimen and upper platen
- Then reduce the loading rate by approximately 12 turns
- Apply the load until failure and record the maximum load  $F_c$
- Once the specimen fails turn the loading valve to minimum
- Open the releases valve
- Stop the pump



**Figure 4 :** compressive strength testing setup

### Water Absorption of specimens

This test allows us to understand the behavior of concrete when expose to water. It consists of determined the amount of water absorbed by normal concrete over time. The specimens were place in an oven for 48 hours after demolding, then weighed to record their dry mass ( $M_d$ ). They were then immersed in water for 24 hours and reweighed to determine the wet mass ( $M_w$ ).

$$A_b(\%) = \frac{M_w - M_d}{M_d} \times 100$$

### 4. RESULTS

At the end of this study it appears that the values of the physico-machanical parameters obtained allow us to compared and analyze the result of the test carried out on conventional concrete samples and those substituted with polystyrene.

**Table 3:** characteristics of raw materials

	Sand	Gravel	Polystyrene	Cement
Water content (%)	5.42	2.51		
Bulk density (kg/m <sup>3</sup> )	1250	1460	8.31	1760
Absolute density (kg/m <sup>3</sup> )	2680	2750	17	2990
Sand equivalent (%)	98.27			
Absorption coefficient (%)	2.5	0.9		

As for the particle size distribution analysis After sieving 2000g of each material and weighing the retain fraction per sieve size, the fineness modulus of the sand was calculated to be  $M_F = 2.62$  classifying it as standard stand.

**Table 4 :** Quantities of materials obtained through mix design

Concrete mix proportions by mass (kg) based on the polysterene content						
% polystyrene	0%	10%	20%	30%	40%	50%
Cement	350	350	350	350	350	350
Sand	773.25	695.92	618.6	541.27	463.95	386.62
Gravel	1095.71	986.14	876.56	766.99	657.42	547.85
Polystyrene	0	1.86	3.73	5.60	7.47	9.34
Theoretical water	210	210	210	210	210	210
Effective water	221	217	207	201	196	191

The theoretical water volume calculated for the preparation of the ordinary concrete is 2428.96 kg/m<sup>3</sup>.

After preparing the different samples, the slump valued were measured according to the polystyrene content. These values were expected to match the target slump  $A = 8$  cm defined during formulation

**Table 5 :** Slump variation concrete with polystyrene content

Specimen	0%	10%	20%	30%	40%	50%
Slump	8	7.8	7.9	7.8	8.1	8
Net water	221	217	214	201	196	191

In this study the bulk density was evaluated using the three samples for each dosage after demolding. The real bulk densities range between 1578 and 2476kg/m cube.

**Table 6:** bulk density valued of concretes

Percentage of polystyrene	0%	10%	20%	30%	40%	50%
Theoritical density	2428.9	2243.10	2057.24	1871.37	1685.504	1499.64
true density	2476	2406	2112	1898	1779	1578

After demolding the samples were weighed ( $M_{dry}$ ) and immersed in water. After 2 7 14 21 28, and 90 days, they were remove from water and reweighed ( $M_{sat}$ ).

**Table 7:** The absorption coefficient variation with respect to polystyrene dosage

Curing days	Percentage of polystyrene					
	0%	10%	20%	30%	40%	50%
3 days	1.27	1.50	2.92	1.54	1.21	1.59
7 days	2.26	1.47	3.05	1.53	1.54	3.31
14 days	3.44	1.42	3.14	1.76	1.83	2.11
21 days	1.54	3.05	3.25	2.12	3.32	2.24
28 days	3.49	1.44	3.29	3.54	2.55	2.40
90 days	1.10	2.60	2.1	1.36	3.64	3.54
	Absorption coefficient (in %)					

After performing compression test on our samples we compared the strength values obtained for ordinary concrete and those with polystyrenes substitution. Results are shown below:

**Table 8 :** Compressive strength values of concrete(MPa).

Curing days	Percentage of polystyrene added					
	0	10	20	30	40	50
3	13.8	9.68	7.56	4.47	2.15	1.37

7	14.98	13.93	8.41	5.7	3.44	2.15
14	18.8	15.41	8.72	6.66	3.83	2.27
21	20.49	17.59	10.81	7.32	4.21	2.88
28	21.04	19.19	13.39	7.89	4.74	3.06
90	33.89	26.55	16.54	14.70	6.39	3.36
Compressive strength of concretes						

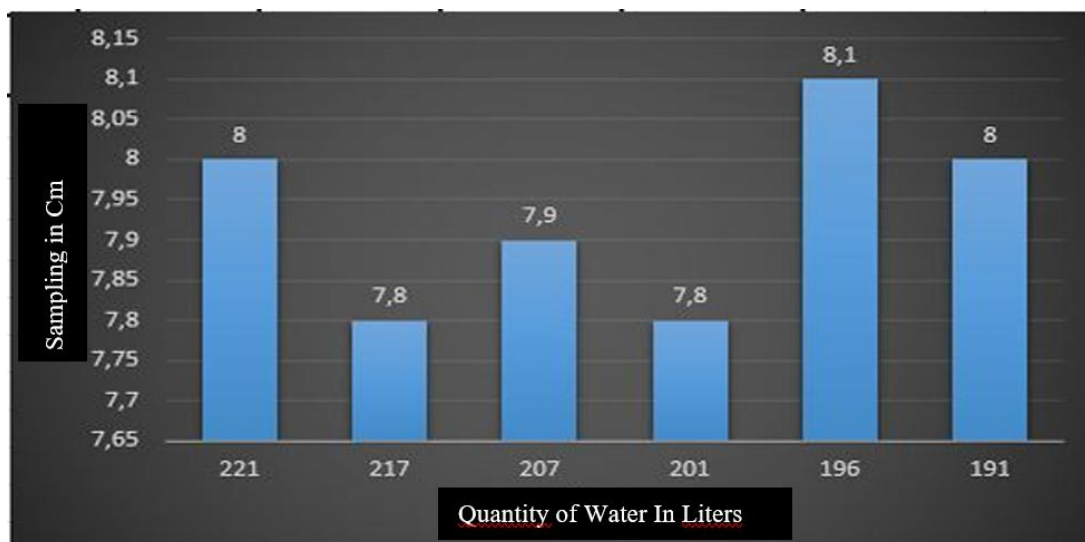
Although reduced, the compressive strength obtained with this formulation are within acceptable range for several structural applications. Based on the densities and strength values, the concretes are classified as structural lightweight concretes.

**Table 9 :** 28 days’ strengths extrapolated from 3-day strength (MPa)

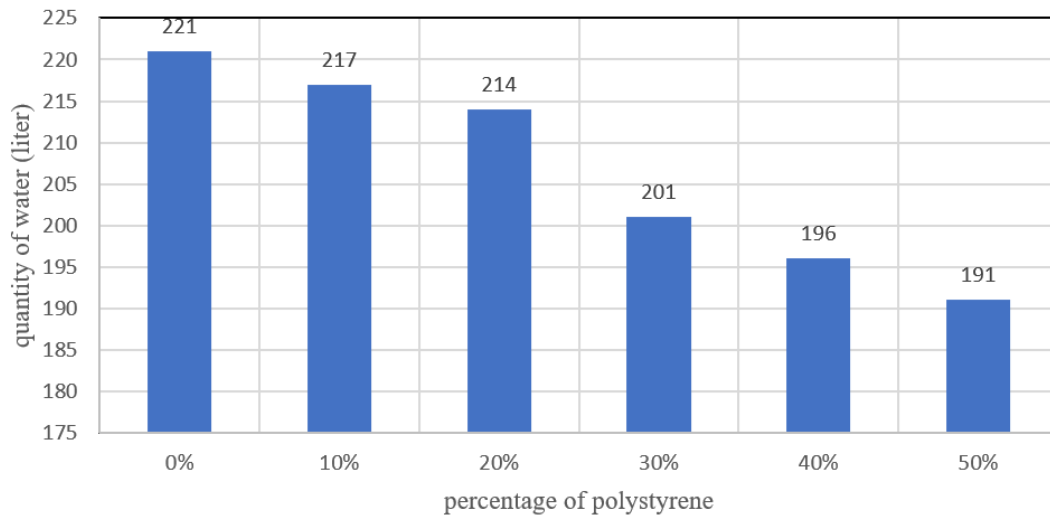
	0%	10%	20%	30%	40%	50%
Actual compressive strength at 3 days	13.8	9.68	7.56	4.47	2.15	1.37
Actual compressive strength at 7 days	21.04	19.19	13.39	7.89	4.74	3.06
Actual compressive strength at 28 days	33.35	23.39	18.27	10.8	5.19	3.31
Actual compressive strength at 90 days	33.89	26.55	16.54	14.7	6.39	3.36

## 5. DISCUSSION

following the various laboratory tests carried out, the following observations were made.



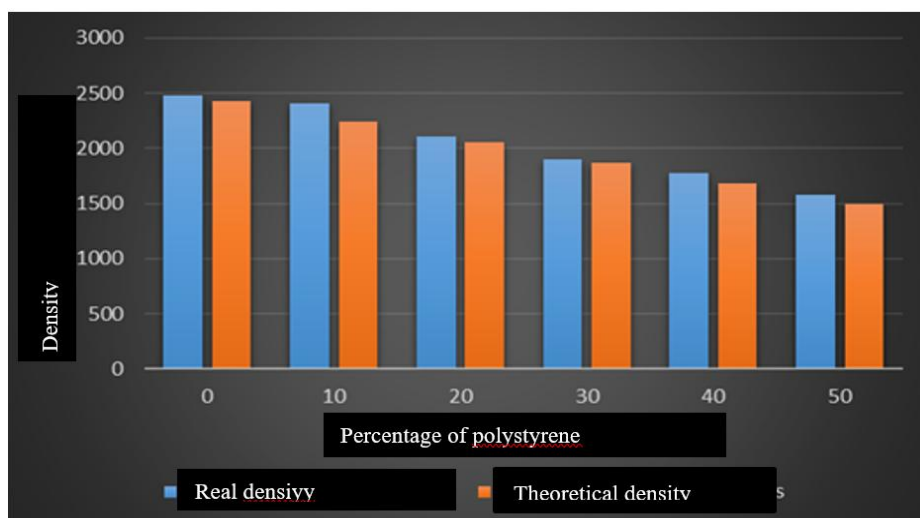
**Figure 5:** Histogram of concrete slump variation with mixing water content



**Figure 6 :** Histogram of mixing water variation with polystyrene addition percentage

It is observed that this values are close to the theoretical value planned during the mix design, namely  $210 \text{ kg/m}^3$  of water. At 0% polystyrene substitution, the water content increase by 11kg compared to the calculated value. This increase may be attribute to the relatively dry mixing surface, the manual mixing technique, the mixing time and the hydration state of the aggregates.

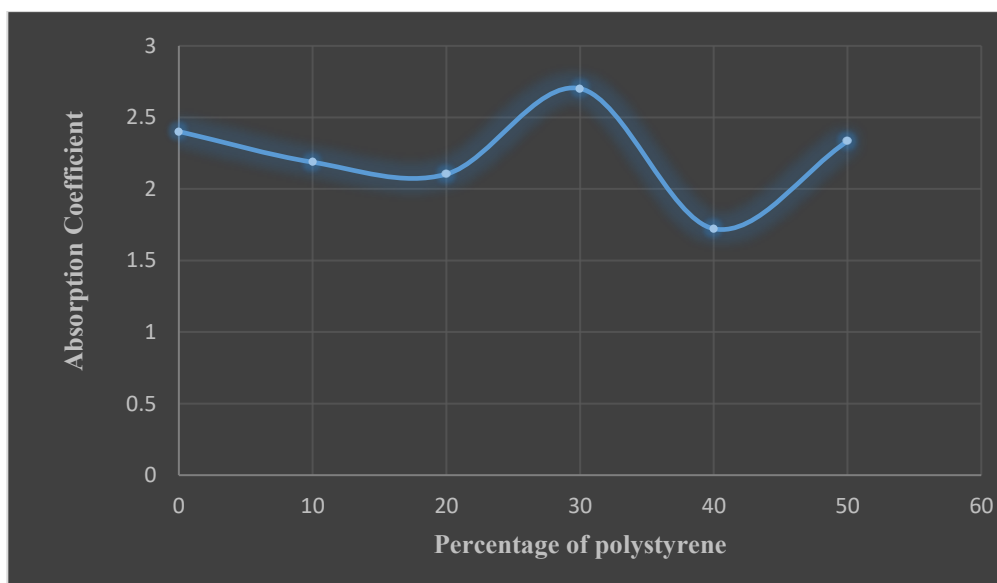
The histogram in figure 6 also a decrease in the mixing water as the proportion of polystyrene increases. Indeed, during mixing, an increase in the workability or plasticity of the concrete was noted as the polystyrene content increased. This reduction may be due to the reduction of the sand and gravel aggregate or to reduce the inter-particle friction caused by the spherical shape of the polystyrene beads.



**Figure 7 :** variation in actual bulk density compared to theoretical bulk density.

The result presented in the histogram show an increase in the bulk density of the samples after demolding. This increase may be due to the added water from moist aggregate (sand and gravel) during mixing, the moisture condition of the mixing surface or the irregularity of the troweled samples surfaces. Moreover, since polystyrene is lightweight materials, its inclusion in concrete reduces the overall weight, both in fresh and hardened state. This is clearly illustrating by the curve which show a decrease in bulk density with increasing polystyrene content.

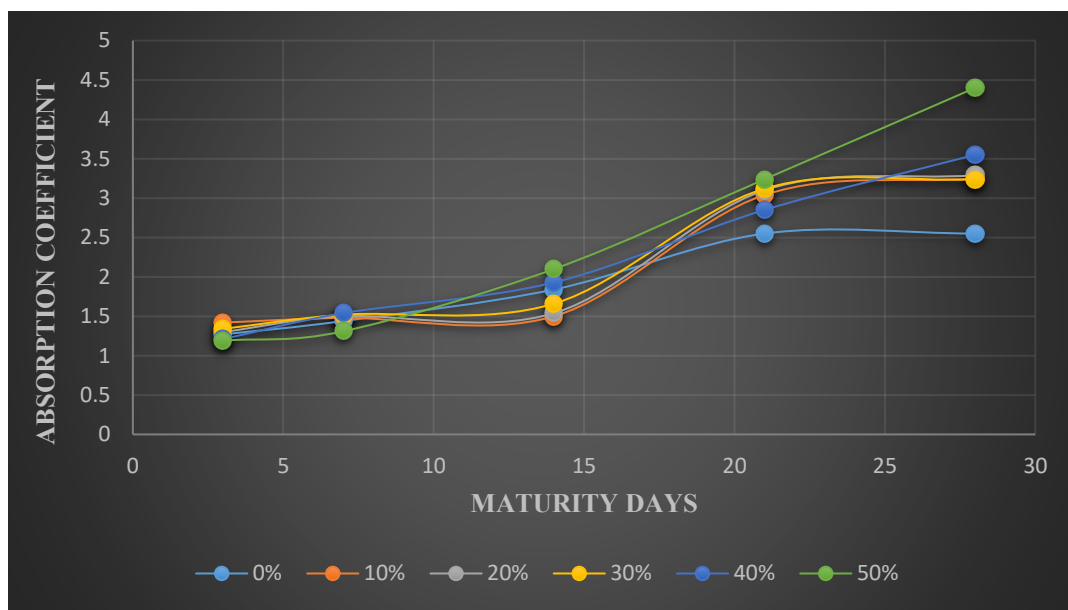
However, although lightweight concrete is known for being easier to work with compared to traditional dense concrete, it should be noted that they are not more suitable for all structural applications. Based on our investigation, concrete mixtures containing between 0% and 50% polystyrene fall to the structural lightweight concrete category, as their density exceed  $1350\text{kg/m}^3$  (according to ACI lightweight concrete classification guidelines). The next step is to confirm this categorization based on compressive strength.



**Figure 8 :** Evolution of water absorption coefficient as a function of polystyrene content

Water absorption in concrete depends on the exposure conditions of the sample, the immersion temperature, the drying method (air or oven), the void volume or porosity within the materials, the amount of heat applied to the polystyrene during thermal treatment, the texture and source of the aggregates, and the absorption kinetics that may vary from one materials origin to another. These factors make the study of water absorption a highly variable and sometimes difficult parameter to quantify.

The addition of polystyrene increases the void content in the concrete, which in turn enhance pore connectivity, facilitating capillary water rise within the sample (Jin et al.). however, this is not reflected in figure 8, which shows the variation of absorption coefficient for each dosage. Water absorption tends to be more or less rapid depending on the microstructure of de cementitious matrix. many researchers have also shown the strong interaction between the cement paste and lightweight aggregates due to their high absorption capacity. According to Mollebi Samira (2014), the discontinuous behavior of absorption in the material may be caused by the chemical, physical and mechanical interactions between the cement paste and lightweight aggregates.

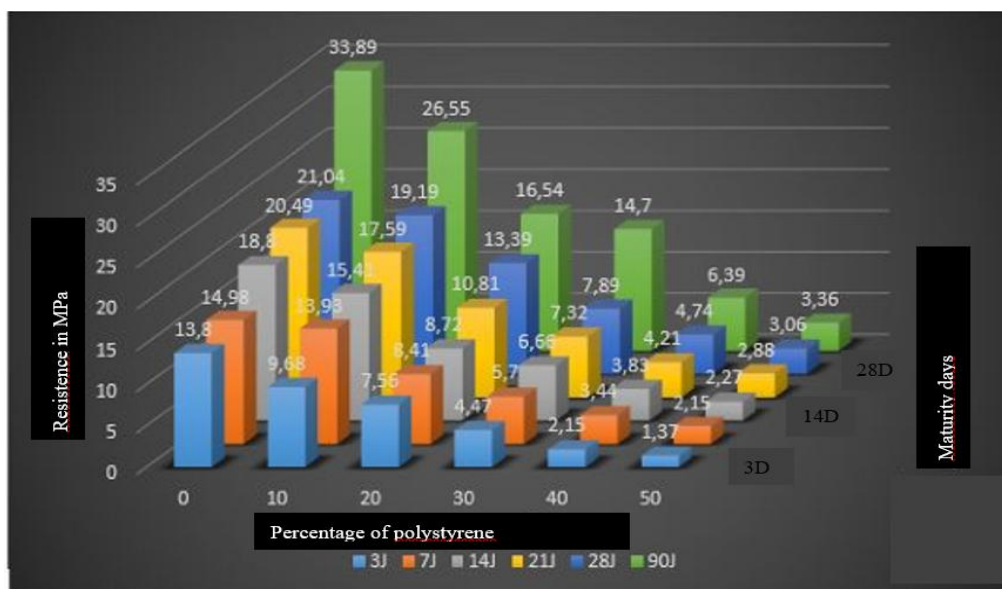


**Figure 9** : curve showing water absorption coefficient showing evolution over time for different concrete specimens

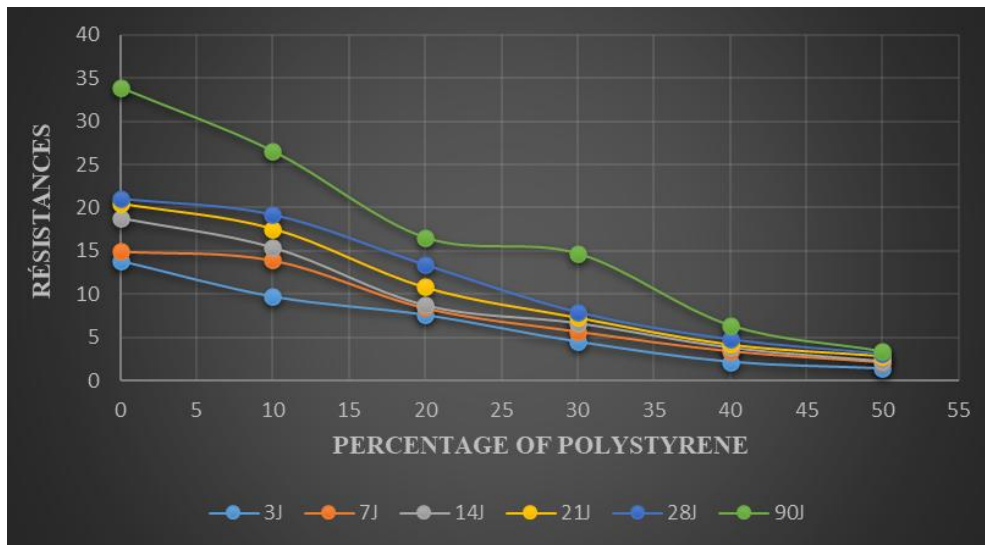
The weights of the samples were used to calculate the absorption coefficients corresponding to each polystyrene content. The mass development of samples stored in water over time shows a non-linear trend, which may result from the materials water retention or release behavior. It is noted that the absorption coefficient over time depending on water exposure duration, samples with 10% 30% and 50% polystyrene substitution show a fairly logical progression (the longer the immersion time the more the water is absorbed or reaches a saturation point), while the behavior of samples with 0%, 20%, and 40% does not follow this logic.

This irregularity could be explained by several factors, including, including the time elapsed between draining and weighing, the hydration process of the cement (which results from multiple chemical reactions that are not entirely understood), or the encapsulation of aggregate particles by the cement paste, which may slow down or even halt the absorption process, as discussed by Alhozaimy (2016).

Moreover, since the test specimen were manually prepared. Marc-Olivier Prevost (2019) explained that the water absorption coefficient of the troweled concrete surface is higher than that of formwork-cast concretes. This is due to the irregularity of the troweled finish, which creates a larger surface area for water contact. Additionally, Sene Licka et al. (2019) note that the cement matrix contains air voids (located between  $\text{Ca}(\text{OH})_2$  or C-S-H hydrates) known as microstructural porosity (ranging from 0.01 to 5 microns) which appear during hydration and drying. Therefore, with this type of progression, water absorption in our material may never reach a completely stable or saturated point.



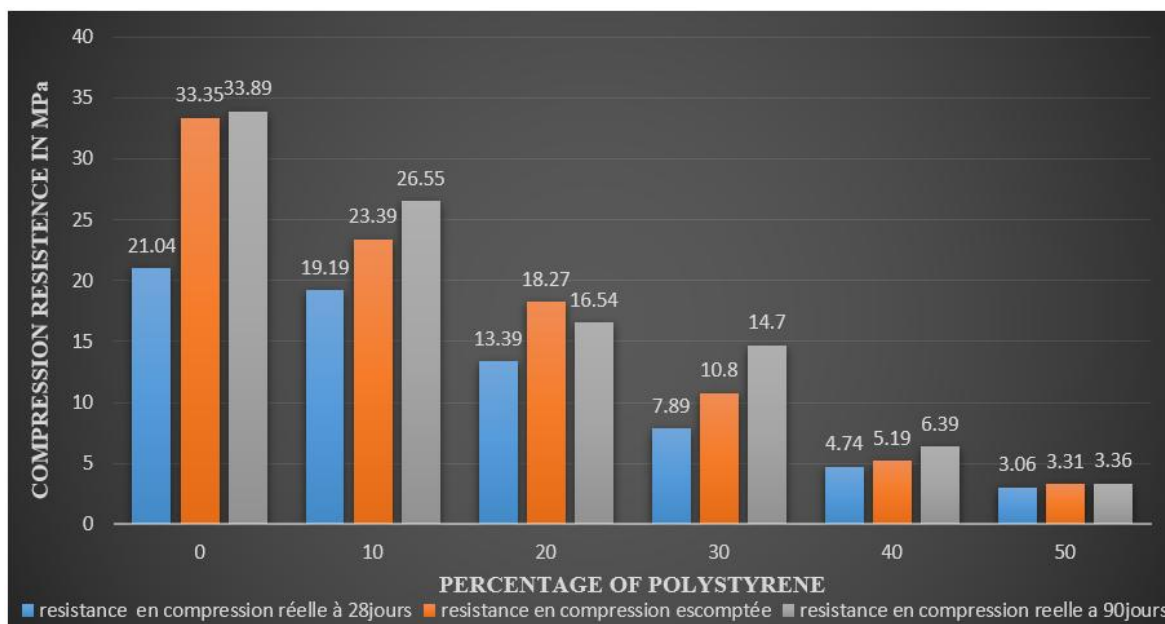
**Figure 10 :** Histogram showing the evolution of compressive strength of concrete samples over time



**Figure 11:** Variation of different polystyrene content with curing age

The results show that compressive strength is directly related to the composition of the concrete. It increases with curing time for all formulations. This is due to the hydration process of the minerals present in the cement, leading to the progressive formation of calcium silicate hydrate and calcium aluminate hydrates, which contribute to the gain in strength over time (Kouidi Bouchra, 2019). We also observed that the concrete containing polystyrene exhibit a decrease in strength as the polystyrene content increases. In other words, the higher the mechanical resistance of the aggregates used in the concrete, the stronger the resulting material will be.

It is also evident that lightweight concrete with 0% and 10% of polystyrene fall in the category of structural lightweight concrete, which make them suitable for all type of structural application: element under bending, tension, or compression. Meanwhile, concrete with 20% and 30% polystyrene can be consider as moderate strength structural lightweight concretes, suitable for load-bearing and insulating structures, such as partition and thick walls, columns, beams, exterior walls, floor slabs, and both new and renovated floor constructions. Concrete containing 40% and 50% polystyrene exhibit low strength and density, making them better suited for non-structural insulating applications, such as floor screeds, sub-asphalt layers, and lightweight fill under slabs.



**Figure 12 :** Variation of 28-day compressive strength with polystyrene content

It can be seen that the expected compressive strength, as estimated during the formulation, is significantly higher than the actual strength measured after testing. The target strength was therefore not achieved. However, it is nearly reached at 90 days of curing. This discrepancy could be attributed to the chemical composition of the cement used, which may not allow optimal strength development. According to earlier studies, the high alkali content in the cement and its reaction with water can reduce the concrete’s expected compressive strength. The quality, quantity, or the composition of the mixing water may also influence this delay. For instance, while 210 liters of water were planned to achieve a compressive strength of  $\geq 25$  Mpa at 28 days, the actual measured amount was 221 liters. This excess water likely evaporated, creating voids within the concrete matrix, and thereby reducing strength. In other words, in hardened concrete, water absorption by aggregate grains and the cement matrix can weaken the material if it is porous, which results in a decline in mechanical performance. Other factors may include: the formulation method of the samples, cement storage condition and duration, the possibility of poor-quality cement from the factory, and also the manual mixing method and time.

## 6. CONCLUSIONS AND PERSPECTIVES

### 6.1 Conclusion

Over the years, advance in concrete science and technology have improved its performance, reduced its environmental footprint, and diversified construction materials. This

has led to growing interest in lightweight concrete. From an ecological standpoint, the use of eco-friendly by-product such as polystyrene in construction offers a promising solution to waste storage and landfill issues. Polystyrene is a renewable resources capable of successfully replacing natural construction materials. In the line with this vision, the present study aimed to assessed the feasibility of substituting conventional concrete components with polystyrene and to define a suitable formulation for optimal application.

## 6.2 Perspectives

The physical and mechanical properties of polystyrene-based concrete appear to present acceptable qualities for specific types of construction, however, other parameters must be considered to achieve a comprehensive understanding of this material. Therefore, future research should focus on:

- The thermal and acoustic behavior of polystyrene concrete;
- The potential of adding pozzolan, volcanic ash, or other admixture to improve compressive strength at higher polystyrene contents or to reduce the void content in the concrete;
- The chemical properties of the cement components and their water absorption kinetics over time.

**Acknowledgments:** The authors extend their sincere thanks to Prof. TALLA Pierre Kisito, Prof. YAMB Emmanuel, Prof, NGAPGUE Francois, Prof. FOTUE Alain, and Prof. GOUAFO Casimir for reviewing this work and providing valuable contributions to its completion.

## REFERENCES

- [1] **Abderabi Rabah.** (2020). Physico-mechanical characterization of a cement mortar based on polystyrene beads. Dissertation, University Ziane Achour of Djelfa.
- [2] **BENAMRANE Dounia Zed.** (2017). The effect of the formulation method on the compressive strength of concrete. Dissertation, University Kasdi Merbah Ouargla.
- [3] **Benzina Ahlem et al.** (2018). Study of the influence of pozzolanic aggregates on the characteristics of lightweight concretes. Dissertations, Civil Engineering Ain-Temouchent.
- [4] **Berredjem Layachi et al.** (2020). Durability of mortars based on recycled sand. Thesis, University Badji Mokhtar.

- [5] Cement based on polystyrene beads. Dissertation, University Ziane Achour of Djelfa.
- [6] Eliane Khoury et al. (2019). Evolution of effective water during the mixing of recycled aggregate concrete. Thesis, Laboratory of Civil Engineering and Geo-environment.
- [7] **KOUIDI BOUCHRA et al.** (2019). Formulation and physico-mechanical behavior of sand concretes with recycled polystyrene aggregates. Dissertation, Faculty of Engineering Sciences.
- [8] **Kunwufine Deodonne.** (2015). Study of the physico-chemical characteristics of recycled aggregate concretes and their environmental impact. Thesis, University of Strasbourg.
- [9] **Mariam Mohaman Dairou.** (2017). Study of the rheological behavior of pile concretes during the placement of reinforcement cages – development of a characterization tool. Thesis, University of Artois.
- [10] **Maxime Lion.** (2019). Study of the relationship between sorptivity and capillarity for different types of concretes. 24th French Congress of Mechanics, French Association of Mechanics.
- [11] **Mohellbi Saamira.** (2014). Characteristics and modeling of physico-mechanical parameters of lightweight concrete with composite aggregates. Thesis, Civil Engineering Tizi-Ouzou.
- [12] **Prévost Marc Olivier.** (2019). Study of water penetration into reinforced concrete under mechanical and environmental stresses. Dissertation, Polytechnique Montréal.
- [13] **Redjel, Khelifi et al.** (2014). Measurement of the compressive strength of concrete. Thesis, University Hadji Mokhtar of Annaba.
- [14] **Salem Merabti.** (2021). Mechanical and thermal performance of composite materials based on expanded cork waste. Doctoral thesis, University of Blida 1.
- [15] **Sene Licka Khadidiatou et al.** (2019). Lightweight aggregate concretes: study of concretes based on expanded clay and seashells produced in Senegal. Dissertation, University of Guelma.

- [16] **Sidi Mohammed ZIANI-KERARTI et al.** (2020). State of the art on the formulation and behavior of lightweight concrete based on expanded polystyrene microbeads. Dissertation, University Aboubakr Belkaïd Tlemcen, Faculty of Technology.

**Citation:** Nie Noumsi Thierry Constant, Kayimbo Kamga Cyril, Bakam Stela, Pelap Francois beceau. (2025). Improving the Physico-Mechanical Performance of Lightweight Concretes with Polystyrene in Cameroon. International Journal of Civil Engineering and Technology (IJCIET), 16(5), 56-74.

**Abstract Link:** [https://iaeme.com/Home/article\\_id/IJCIET\\_16\\_05\\_004](https://iaeme.com/Home/article_id/IJCIET_16_05_004)

**Article Link:**

[https://iaeme.com/MasterAdmin/Journal\\_uploads/IJCIET/VOLUME\\_16\\_ISSUE\\_5/IJCIET\\_16\\_05\\_004.pdf](https://iaeme.com/MasterAdmin/Journal_uploads/IJCIET/VOLUME_16_ISSUE_5/IJCIET_16_05_004.pdf)

**Copyright:** © 2025 Authors. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

**Creative Commons license:** Creative Commons license: CC BY 4.0



✉ [editor@iaeme.com](mailto:editor@iaeme.com)