PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND

SCIENTIFIC

RESEARCH

KASDI MERBAH UNIVERSITY OUARGLA

Faculty of Applied Sciences

Department of Civil Engineering

Memory

Presented for the graduation of MASTER

Field: Civil Engineering

Specialty: Structures

Presented by :

MEHIRI IKRAM HADIL

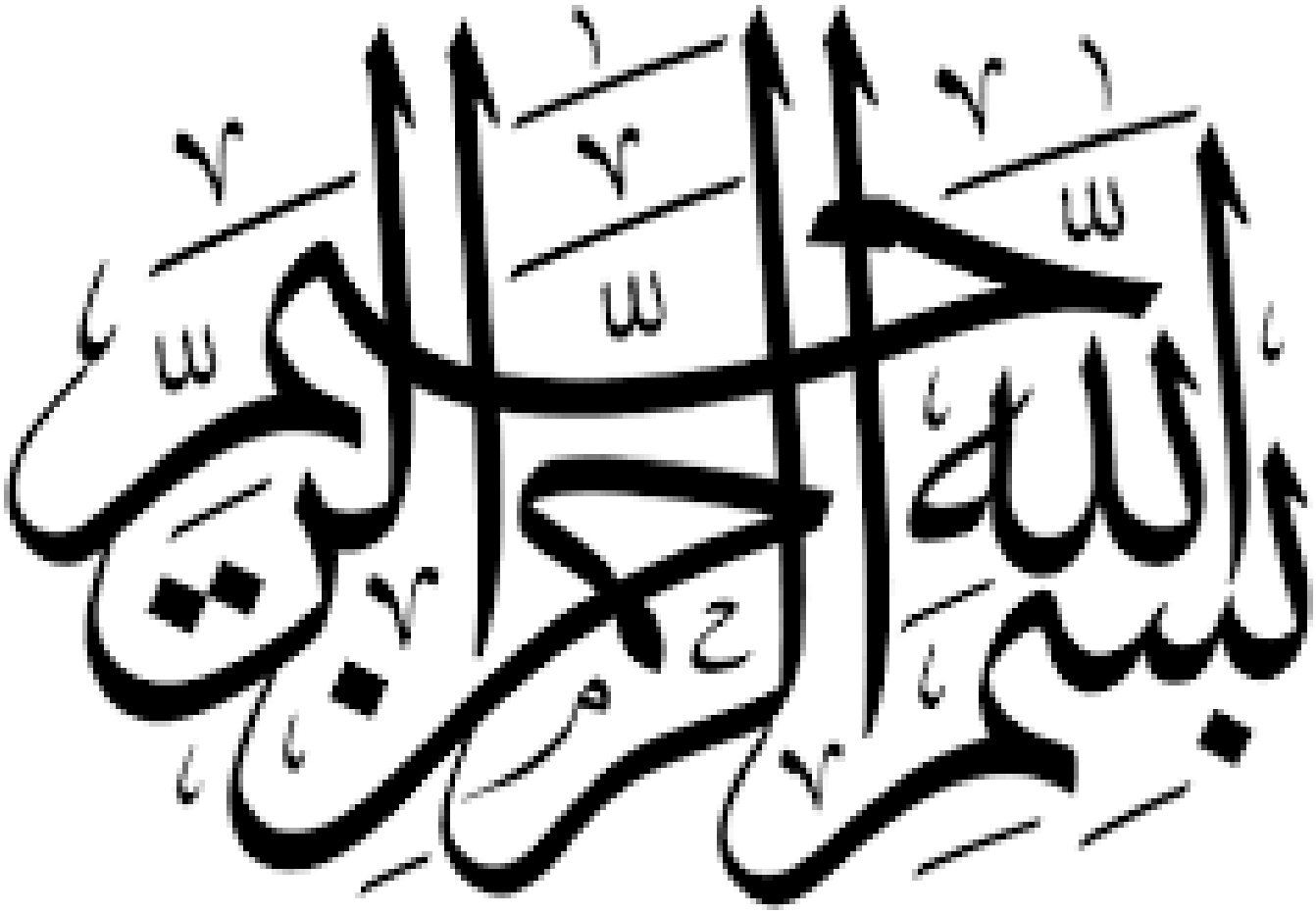
Theme :

Production Vad-Vad Blocks with Timchemt base And Glass Waste

in front of the jury composed of:

Dr. Akchiche Hamida	MCB (UKM Ouargla)	President
Dr.Mekharmeche Abdessalam	MCA (UKM Ouargla)	Examiner
Dr. Kebaili Nabil	MCA (UKM Ouargla)	Supervisor
Dr.Chaib Hachem	MCA (UKM Ouargla)	Co-Supervisor

University year:2023/2024


بسم الله الرحمن الرحيم

Dedication

In the name of God , the merciful and peace be upon the honorable messengers

To my dear parents

They were and still are my greatest source of inspiration and support. Dear Mum, dear Dad.

To my honorable family

who stood by my side at every moment and supported me with love and dedication. To my brothers and sisters by name.

To my honorable teachers at all stages.

I benefited from their knowledge and guidance, and they did not skimp on information and were the beacon that illuminated the path of science and knowledge for me.

To Dr Hachem Chaib

without whom this thesis would not have been complete

To my dear colleagues

You have shared my study journey with me, and you have been my best support and good companions at every step.

To everyone who contributed to this achievement from near or far.

Finally, my ambitious spirit that did not give up, which was the strongest motivation to achieve this achievement.

I offer you all this work as an expression of my thanks, gratitude, and love.

Acknowledgements

As the Prophet Muhammad (peace be upon him) said:

"He who does not thank people does not thank Allah.

I praise and thank God for His help in completing this

memorandum, which I hope will satisfy Him.

Then I extend my sincere thanks and gratitude to :

- Dr Hachem chaib for guiding, advising and supporting me to throughout the preparation of this memorandum.
- Dr Kebaili Nabil for his guidance in this memorandum.
- The members of the Discussion Committee for agreeing to discuss my thesis.
- Mr Ali Kchired, who did not spare his help and advice.
- My colleagues who gave me moral support and encouraged me to continue **(NESRINE, MOUSSA,RANIM,AYOUB, MAHDIA, CLUB MEMBERS)**
- Laboratory of Study and Control (LEC) for Their reception and guidance.
- My family and all those who contributed to the completion of this work.

ملخص

يهدف هذا المشروع إلى إنتاج طوب الفاد فاد بدون الحاجة للملاط او اي وصلات ، في صناعة هدا الطوب استخدمنا الجبس التقليدي (التيمشمت) لمنطقة ورقلة ومسحوق الزجاج قصد تحسين الخواص الفيزيائية والميكانيكية لطوب التيمشمت في سياق تثمين واستغلال الموارد المحلية التي تتوفر عليها منطقة ورقلة بكثرة وللتقليل من مخلفات الزجاج واستخدامها في هدا المشروع ، النتائج المتحصل عليها أظهرت أن الخلطة (PDV2% T68 %) هي الأفضل من الناحية الميكانيكية .

الكلمات المفتاحية : الطوب, الجبس التقليدي (التيمشمت), مخلفات الزجاج, الخواص الميكانيكية ,الخواص الفيزيائية.

RÉSUMÉ

Ce projet vise à produire le vad-vad block sans besoin de mortier ni aucun joint, dans la confection de ces briques nous avons utilisé le gypse traditionnel (Timchemt) de la région de Ouargla et la poudre de verre pour améliorer les propriétés physiques et mécaniques de ces briques , dans le cadre de la valorisation et l'exploitation des ressources locaux que la région de Ouargla possède en abondance, et réduire les déchets de verre et son utilisation dans ce projet les résultats obtenus ont montré que le mélange (T68% PDV 2%) est le meilleur d'un point de vue mécanique.

Mots clés : briques, Gypse traditionnel (Timchemt), Déchets de verre, Propriétés mécaniques, Propriétés physiques.

ABSTRACT

This project aims to produce the vad-vad block without the need for mortar or any joints, in the making of these blocks we used the traditional gypsum (Timchemt) of Ouargla region and glass powder to improve the physical and mechanical properties of Timchemt block in the context of valuing and exploiting the local resources that the Ouargla region has in abundance and reduce the waste of glass and its use in this project, the results obtained showed that the mixture (T68% PDV 2%) is the best from the mechanical point of view.

Keywords: block,Traditional gypsum (Timchemt),glass waste ,Mechanical properties, Physical properties .

ABSTRACT

Chaptre I

Chaptre II

Chaptre III

List of figures

Chaptre I

Chaptre II

Chaptre III

List of tables

General Introduction

The vast history of brick construction has allowed us to build structures of various kinds across numerous civilizations and years. Over time, new innovations in construction and building materials have provided more suitable options for creating the structures we need. The traditional brick and mortar that many are accustomed to has proved its worth. However, with the increasing need for time and cost efficient building solutions, interlocking concrete blocks have emerged as an ideal solution to meet these needs.

Today we have other options to build structures reliably, quickly and with less labour. One of these options is interlocking concrete blocks. To facilitate this process, I turned to the use of timchemt in the construction of these blocks, as it is a locally available material with numerous advantages, in particular its suitability for the high temperatures of the Ouargla region.

To improve the mechanical and physical properties of the Timchemt, I added glass powder. This not only improves the quality of the blocks, but also contributes to the recycling of glass waste and reduces environmental pollution, reflecting a commitment to environmental sustainability.

In this regard, the specific aim of our work is to optimise and enhance the traditional gypsum material and thus improve the mechanical and physical properties of Timchemt, by Studying the effect of adding glass powder in specific proportions from 0% to 5% by making samples with dimensions of 160 x 40 x 40 x 40 mm^3.

The work is structured as follows:

- ✓ Chapter One: Provides a general overview of vad-vad block (interlocking block), Timchemt and glass powder.
- ✓ Chapter Two: Presents the various experiments and the physical and chemical properties of the materials used.
- ✓ Chapter three: Mechanical and physical experiments, and interpretation of the results

chaptre I
Bibliographic study

I.1.introduction

The construction industry faces many challenges related to the time, cost and skill required to build straight and durable walls. Traditionally, the construction process requires the use of advanced alignment tools and a high level of skill to ensure accurate alignment and connection between bricks, VAD-VAD Block is an effective solution to these problems thanks to its asymmetric interlocking design, which simplifies the construction process and ensures high quality without the need for special tools or skills.

I.2.Concrete Block [1]

is a 'Building Block' composed entirely of concrete that is then mortared together to make an imposing, long-lasting construction. These construction blocks can be 'Hollow' or 'Solid,' formed of ordinary or lightweight concrete in various specified sizes, depending on the precise requirements. Concrete blocks come in various shapes and sizes, and they can be solid or hollow.

I.2.1.Types of Concrete Blocks [1]

There are two types of concrete blocks:

a) Solid concrete blocks

which are highly heavyweight and formed by aggregate, are primarily utilized in construction projects. They're sturdy and give structures a lot of solidities. These solid blocks are ideal for large-scale projects such as force-bearing walls. They're compared to bricks that come in big sizes. As a result, constructing concrete masonry takes less time than brick masonry.

Figure I 1: solid concrete blocks **[2]**

b) Hollow Concrete Blocks

In masonry construction, hollow concrete blocks are typically employed. It reduces labour costs on the job site while also speeding up the construction process and saving cement and steel. These blocks reduce the natural weight of masonry structures while also improving physical wall qualities like noise and thermal insulation. Standard hollow concrete blocks come in two sizes: Full size and half size. Half-sized blocks are cubical and have one core, while full-sized blocks are rectangular and have two cores. Hollow concrete blocks come in various shapes, sizes, and designs, depending on the shape, needs, and design.

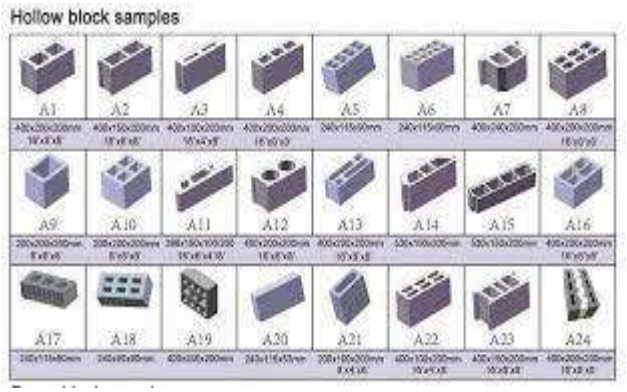


Figure I 2: Hollow Concrete Blocks [3]

I.3.Vad-Vad block

It is a type of Interlocking Concrete Block and it is a unique form of pre-cast concrete blocks that are designed to hold together by using pre-measured recesses. Built with unique profiles and features, which allow them to fit perfectly into each other without the use of any mortar. Instead, the cementitious blocks simply snap together with each other.

it's made to be used as part of the building process since they're affordable. It can be used as a temporary or permanent feature, this is why many home remodelling projects employ interlocking blocks as a building material. Additionally, there are many benefits when using this type of concrete construction material. **[4]**

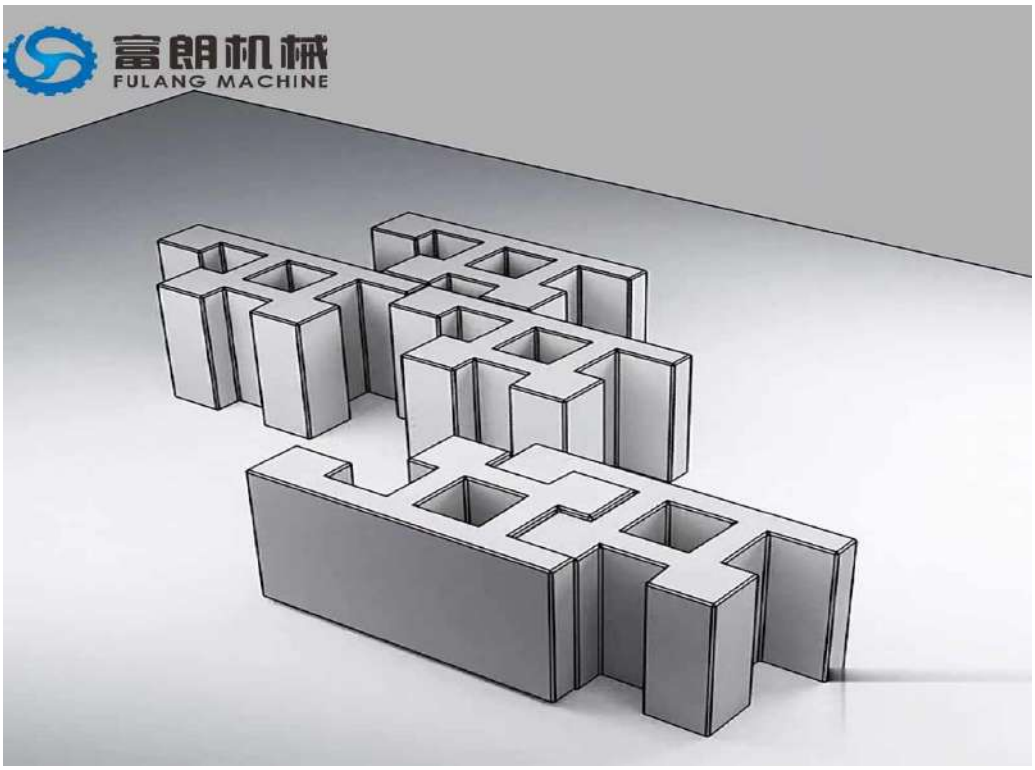


Figure I 3:Vad -Vad block [5]

I.3.1.Vad- Vad Block Applications

Vad-vad block can be used in many areas such as stairs ,internal and external walls ,floors,columns ,Cocrete Walkways,Packages, Roofs,Agricultural structures,Separation barriers,Retaining walls, Industrial buildings ,Fire breaks ,Material Storage bays,Blast walls.

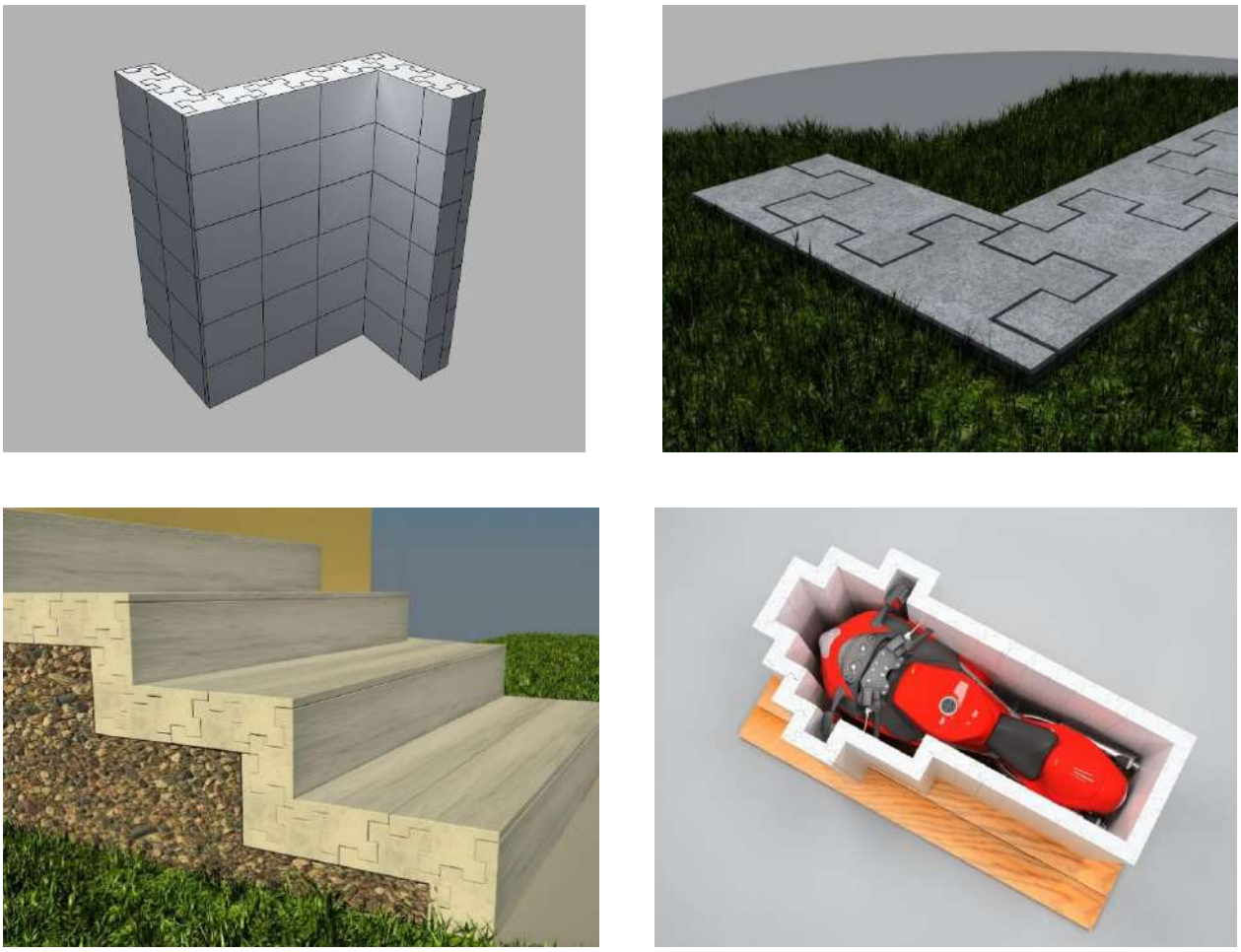


Figure I 4:Vad- Vad Block Applications [6]

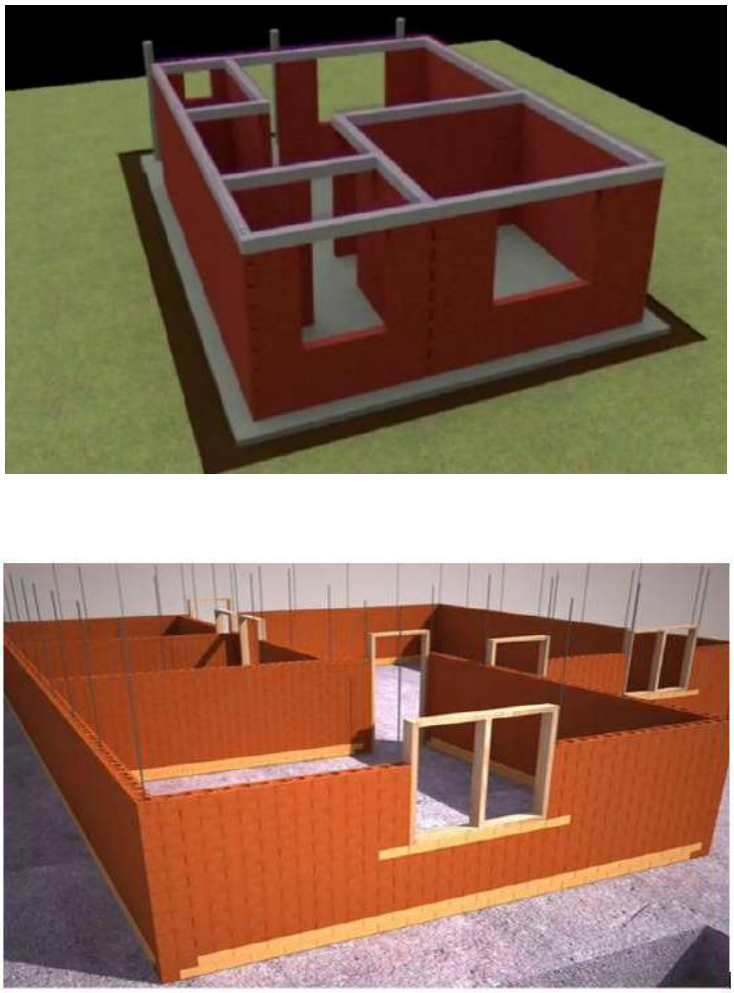


Figure I 5 : Interlocking Brick Houses [7]

I.3.2.the benefits of vad-vad block

- A single shape for constructing a wall and cornered structures
- Ability to self-interlock without the need for additional elements or accessories
- Quicker and less hassle to install
- Ability to self-interlock without the need for additional elements or accessories
- Eliminates possibility of error assembly and alignment
- Eliminates waste of construction material - the shape is such that there is no excess material when production
- Ability to transport without risk of damage
- Appropriate for temporary and/or permanent buildings

- No need for mortar, saving you money and time
- Resistant to extreme weather conditions
- Sound resistant
- Fire-resistant properties, mitigating the spread of fire depending on structure
- Little maintenance required
- Often, no foundation is needed before installing
- Sustainable
- Ability to stack them upon each other
- Flexibility in sizes
- Unlikely to be displaced due to the interlocking function
- Can be moved with standard lifting equipment

I.4.Traditional gypsum (Timchemt) [8]

It is an evaporitic sedimentary rock of the gypsum type, originating from the same gypsocalcareous source rocks located in arid and semi-arid climatic zones. It is composed primarily of semi-hydrated calcium sulphate (CaSO4·1/2 H2O) in accordance with the following reaction:

CaSO42H2O CaSO4 +1/2 H2O +1/2 H2O

it is Used as a hydraulic binder to bind walls and floors are also

used in tiles, sculpted decor, interior and exterior plastering ,It takes on a grey colour

after baking in a traditional oven for a period ranging from (4 to 5 h) up to several days before

its use in the construction process

I.4.1.The preparation of traditional gypsum (Timchemet) [9]

a) Stone extraction

This fragile limestone is quarried from areas near construction sites,It is mostly in the form of shallow horizontal stone layers that are found at a depth of one metre in Ouargla.

For example, after it is crushed and prepared, it is transported to the incinerator and its shape is as in the following picture.

Figure I 6: Timchemt Stone extraction [9]

b) The burning

The burning process is carried out in specially prepared furnaces that are often close to the place of stone extraction, characterised by their location on the slopes These furnaces are generally conical in shape and are made of stones and clay, the stones to be burned are placed in the kilns where the stones of large sizes are placed at the bottom after gradually placing the stones of smaller diameter until the opening is closed for burning, The firing process lasts for at least 8 hours at a temperature of 150 to 200 degrees Fahrenheit.

Figure I 7: Timchemt burning [9]

c) Grinding

After the burning process, the stone blocks are extracted and are fragile and easily crumbled, and after grinding them with a thick wooden pestle or iron hammer, a powder of yellowish-white and light grey colour is obtained, and Timchemt is composed of the following materials : 88% lime carbonate, 11% aluminium silicate and other impurities and 1% calcium chloride.

The obtained powder is then purified, sometimes by sieving, producing several varieties according to the size of the granules, The fine powder is used for interior cladding while the coarse is used as mortar and is used in wall construction, roofing and building domes and others

Figure I 8.Timchemt grinding [9]

I.4.2.Characteristics of traditional gypsum (Timchemt) [9]

Rapid hardening due to its high charcoal content.

- ✓ Resistance to bending.
- ✓ Cool in summer and warm in winter.
- ✓ Economical in cost.
- ✓ Its average lifespan ranges from 100 to 120 years, which is greater than the lifespan of concrete.
- ✓ Heat and sound insulation at the same time.
- ✓ Lightweight characteristic
- ✓ Easy to mould thanks to its softness before drying.

- ✓ Its rigidity and hardness after drying, which ensures its continuity for a longer life. As for the way it is manufactured, the designs varied between traditional and modern.

I.5.Solid waste [10]

Solid waste is defined as solid matter accumulated by various human activities in different areas of the same size and occupancy. It is inevitable that this waste must be disposed of, and therefore a place must be found for it. Previously, solid waste did not pose any environmental problems. It was used by certain organisms in their lives, and in this form these materials were recovered and recycled in the process. There are several reasons for increasing the amount of solid waste, including:

1. Population growth.
2. Agricultural development.
3. Consumption ratio increase.
4. Industrial development and production ratio increase.
5. Technological development.
6. Lack of environmental awareness among the population.
7. Failure to take appropriate measures to deal with solid waste.

These factors have led to a substantial increase in the quantity of solid waste, and the accumulation of solid waste has become one of the most significant environmental problems facing the modern civilised world.

I.5.1.Type of solid waste

a) Hazardous solid waste [11]

is defined as the waste resulting from various activities and processes or their ashes that retain the properties of hazardous substances. These substances have no original or alternative after-uses and are considered a source of imminent danger to human health and environmental components. This waste is generated by numerous sources, including industrial and agricultural sources, hospitals, health and pharmaceutical facilities, as well as the waste of residential activities within homes.

It is occasionally generated from the waste of domestic activities within the home, and sewage or industrial sludge may also contain components that render it hazardous.

b) Non-hazardous solid waste

is defined as a solid waste that does not contain substances or components that have the characteristics of hazardous substances. These materials vary in their chemical and physical properties and include organic and inorganic materials, for examples:

b.1.Municipal solid waste [10]

is defined as all everyday items discarded by households, commercial and institutional entities, 1horticulture and road sweeping. This encompasses a diverse range of materials, including packaging, paper, cardboard, food waste, plastic bags and containers, glass bottles, grass clippings, furniture, tyres, electrical and electronic items, and metals.

b.2. Agricultural and animal waste

Agricultural waste encompasses primary crop residues left in the field after harvesting and animal waste after harvesting, as well as secondary processing residues from crop harvests during the production of food, animal feed and fibres. This is generated during the production and distribution process by the decomposition of foodstuffs, vegetables, or meat. It also includes the removal of unusable parts.

b.3.Industrial Waste

Waste produced by industrial companies manufacturing organic chemicals, inorganic chemicals, iron and steel, plastics, resins, stone, clay, glass, concrete, pulp and paper, food and related products.

b.3.1.Waste from the demolition and construction process

It is a waste resulting from urban development in most cities and villages and produces piles of dust and construction debris that are left

on pavements and public roads.

b.3.2.Inert waste

is the most stable type of waste. When landfilled, it does not undergo any significant physical, chemical or biological changes and does not present any risk to the environment.

Inert waste produced by the construction sector includes the following materials:

oncrete, Bricks, Breeze blocks, Tiles and ceramics, Unpolluted and unmixed earth and aggregates

b.3.3. Ordinary waste

is defined as non-inert, non-hazardous industrial waste generated by public or private commercial, craft, industrial or service activities. Such waste does not present any particular danger to people or the environment and can be disposed of in the same way as household waste. Such waste includes cardboard, paper, plastic, plaster, glass, wood used in construction, etc.

Additionally, it encompasses glass, timber, and metals.

b.3.4.Medical waste

The term "biomedical waste" is used to describe any waste produced in healthcare establishments. This includes hospitals, clinics, doctors' surgeries, dentists' surgeries, blood banks, homecare facilities, funeral homes, medical research facilities and laboratories.

Figure I 9: medical waste [12]

I.5.2.Solid waste treatment methods [11]

This refers to the methods by which the properties of hazardous solid wastes can be changed to make them non-hazardous or less hazardous, so that they can be handled more safely and can be transported, collected, stored or disposed of without causing harm to humans and the environment. Some of the methods are

used are the following:

a) Sanitary backfill

Landfilling is one of the most popular methods of solid waste disposal, and landfill sites must be characterised by special engineering specifications. This is because landfill relies on stacking solid waste to accommodate the largest quantity and to minimise permeability, as well as covering the waste with an impermeable and insulating clay layer. It would also be advisable to choose the landfill site after a geological study of all alternative sites, in order to ensure that the environment is not harmed by the leakage of liquids resulting from the decomposition of waste to groundwater.

b) Burning

This method is one of the most widespread globally in recent years, and is done either through high-tech incinerators or simply open burning in yards

This method is used due to the lack of space available for sanitary backfill.

c) Waste recycling

It is the recycling of waste after collecting and sorting it to benefit from some of its components for different purposes.

I.5.3.The environmental impact of recycling [13]

The economic and environmental benefits of recycling are considerable. These include the following:

1. Protection of resources, reduction of waste, creation of jobs, protection of nature and saving of raw materials.

2. Recycled steel saves iron ore.

3. Every tonne of recycled plastic saves 700 kg of crude oil.

4. Recycling 1 kg of aluminium can save around 8 kg of bauxite, 4 kg of chemicals and 14 kWh of electricity.

5. Aluminium is 100% recyclable; 1 kg of aluminium yields 1 kg of aluminium (after it has been melted down).

6. Each sheet of recycled paper saves 1 L of water and 2.5 W of electricity, as well as 15 g of wood

I.5.4.Waste Recovery in Civil Engineering

Civil engineering work involves three main categories of waste:

inert waste, Ordinary waste ,hazardous waste.

Figure I 10: hazardous waste [14]

Figure I 11: ordinary waste [15]

Figure I 12: inert waste [16]

I.6.Glass [17]

an inorganic solid material that is usually transparent or translucent as well as hard, brittle, and impervious to the natural elements. Glass has been made into practical and decorative objects since ancient times, and it is still very important in applications as disparate as building construction, housewares, and telecommunications. It is made by cooling molten ingredients such as silica sand with sufficient rapidity to prevent the formation of visible crystals.

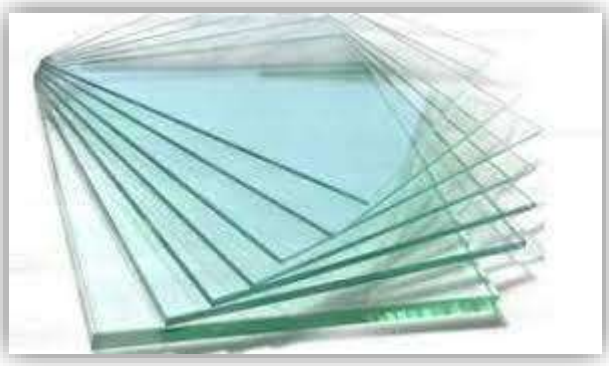


Figure I 13 : glass [18]

I.6.1.Components of ordinary glass

75% silica (silicon oxide).

15% soda (sodium oxide).

10% lime (limestone that contains calcium oxide)

I.6.2.Recovery of waste glass [13]

Glass waste is a serious environmental problem, due to the continuing increase in disposable packaging products and the expansion of the glass industry. This waste has serious consequences for the environment.

In Algeria, glass waste has increased and is having an increasingly negative impact on the environment. On the other hand, economic and environmental problems are generated by the cement industries because of the need for large quantities to meet the high demands of construction projects, high emissions of greenhouse gases and the intensive use of energy and extreme use of natural resources

I.7.Glass powder [13]

is a white alternative cement additive. It is obtained after collecting and grinding fragments of coloured glass. Its high amorphous silica SiO2 gives it pozzolanic properties, combining with lime to produce other hydrates.

Figure I 14: glass powder [19]

I.8.Conclusion

This bibliographical study enabled me to study

- The materials used in my research, namely traditional plaster from the Ouargla region as the main material.
- The types of concrete blocks (solid, hollow, interlocking, etc.).
- vad-vad block and its advantages and applications.
- We have referred to the recycling and reuse of waste in the production of bricks.

(The solid waste used in our research is glass powder).

Chapitre II

Characteristics of the materials used

II.1.Introduction

This chapter presents the properties of various materials through experiments, physical and chemical analyses. The aim is to identify the components of traditional gypsum (timchemt) and additives such as cement, gravel, glass powder, and water. The experiments were conducted at :

- Civil Engineering Laboratory at Kasdi Merbah University Ouargla,
- Study and Observation Laboratory (LEC).

II.2.The materials used

II.2.1.traditional gypsum (Timchemt)

As with most sedimentary rocks, gypsum is composed mainly of calcite (CaSO4, 2(H2O)), which gives it its plasticity. In this study, we used traditional gypsum from the OUARGLA region **[20]**

Figure II 1: traditional gypsum (Timchemt)

- ✓ Granular analysis;
- ✓ Granular analysis by sedimentation;

- ✓ Apparent volumetric mass experiment;
- ✓ Absolute volumetric mass experiment;
- ✓ Methylene blue experiment;
- ✓ Chemical analysis experiment;
- ✓ X-ray neutrality experiment.

a) Granular analysis (NF P94-056)

The experiment involves categorising the granules of the sample by using a series of sieves placed on top of each other in descending order. The studied sample is placed in the uppermost sieve, and the order of the granules is determined by the automatic vibrations of the sieves. Granulometric analysis enables the determination of the quantity and proportion of granule diameters within a sample, as well as the radial distribution of Timchemt granules.

Figure II 2:Sieves used in the experiment

b) Granular analysis by sedimentation (NF P 94-057)

The objective of sediment measurement is to ascertain the particle size gradient of cohesive soils with a grain diameter of less than 0.08 mm or (0.1 mm).

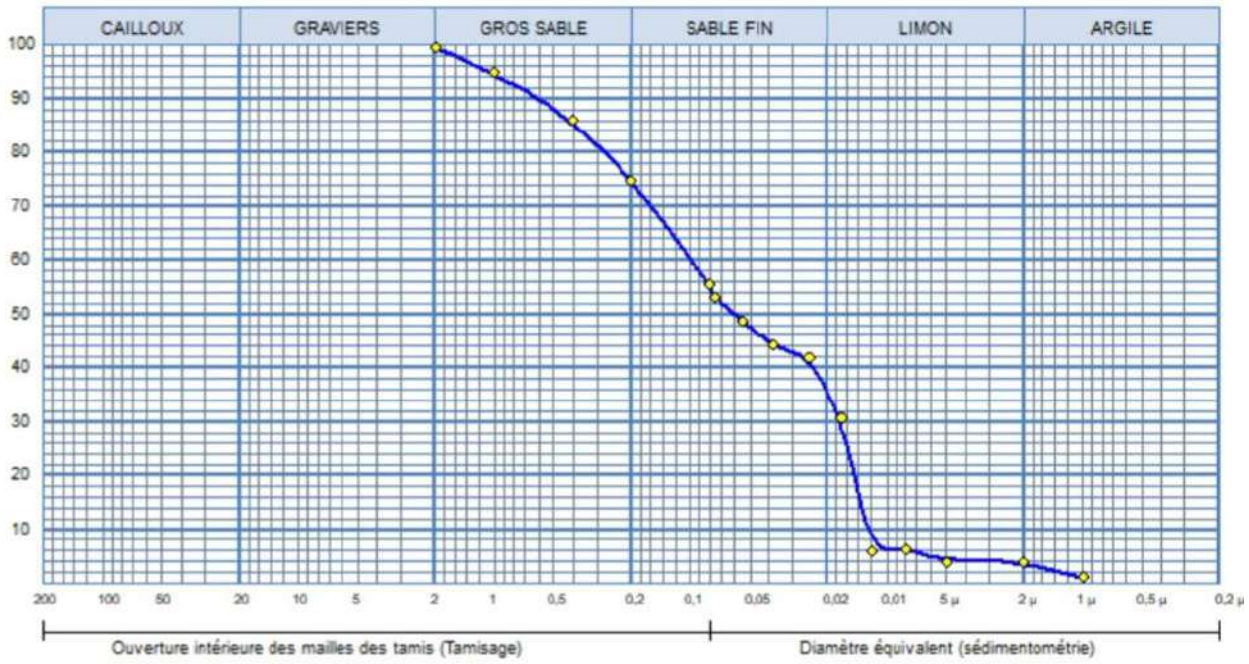


Figure II 3: granular analysis curve of traditional gypsum.

I conclude that this material contains 26% of coarse grains, 38% of fine grains, 32% of silt and 4% of clay.

c) volumetric mass experiment (NF P 94-054) [21]

Volumetric mass is a physical quantity that represents the mass of matter per unit volume.

- **Apparent volumetric mass**

Volumetric mass measurement with voids,The bowl should be filled with sand by hand, with the hand positioned 10 cm above the edge of the bowl. A ruler should then be used to remove any excess sand, ensuring that no voids are left on the surface of the bowl. The weight of the bowl and the Timchemt should then be recorded.

The experiment should be repeated three times, with the results recorded in the table.

Formula used to calculate :

$$\rho a = \frac{M}{V} \text{.....Equation II.1}$$

ρa : Apparent volumetric mass

M: sample mass

V : sample volume

Figure II 4: Apparent Volumetric Mass Experiment

- **Absolute volumetric mass**

Volumetric mass measurement without voids weigh a quantity of timchemt and fill the graduated tube with water to V1, then Carefully pour the timchemt into the tube and take note of the new water level "V2"

Repeat the process three times.

Formula used to calculate :

$$\rho_{abs} = \frac{M}{v2-V1} \quad \text{..... Equation II.2}$$

Figure II 5 : Absolute Volumetric Mass Experiment

Table II 1 : **Absolute and apparent Volumetric Mass results**

The apparent volumetric mass	**1.38 g/cm³**
The absolute volumetric mass	**2.6 g/cm³**

d) Methylene blue experiment (NF P 94-068) [21]

The methylene blue test is a method for determining the clay content of sand, aggregate, and soil. This test is used to measure the amount of clay particles present in a sample.

Formula used to calculate :

$$\mathbf{VBS} = \frac{V \times 0.01}{Ms} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{Equation II.3}$$

V : Methylene blue volume added

Ms : Mass of sample added

The value of methylene blue for timchemt is : VBS = 0.16

Table II 2: Soil classification

VBS≤ 0.2	**Sandy soil (Water-insensitive soil)**
0.2 <VBS≤ 2.5	loamy soil (unplastic, water-sensitive soil)
2.5<VBS≤ 6	loamy soil –clay soil (Medium Plasticity Soil)
6<VBS≤ 8	Clay soil
VBS> 8	Very clay soil

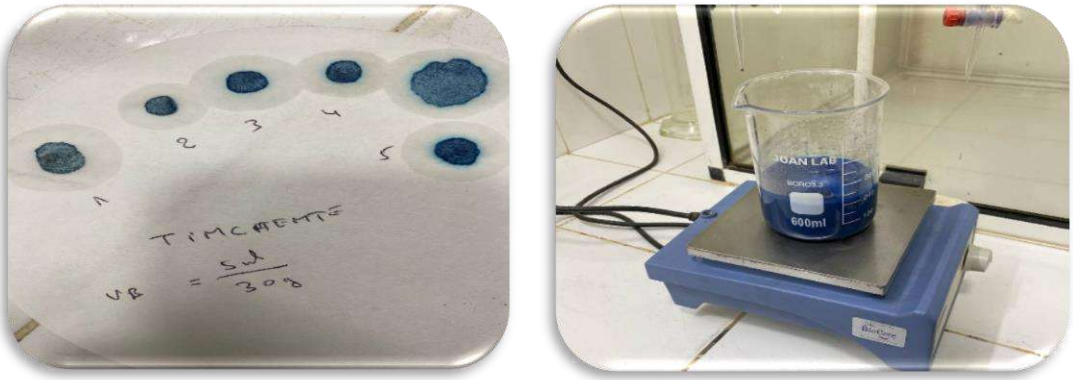


Figure II 6: Methylene blue experiment

The classification of our sample is VBS≤ 0.2 From the result, we can conclude that the soil is sandy.

e) Chemical experiments

Objective of the experiment :

- Identify the components of conventional gypsum (sulfate, carbonate, chlorides).
- Determine the percentage of elements.

Figure II 7: Chemical experiments

Table II 3: Chemical analysis of traditional gypsum (Timchemt)

	components	Values
Insolubles	Insolubles	19.9 %
Sulfate	$SO3^{-2}$	35.64 %
	Ca SO4 / 2H2O	76.8 %
	$SO4^{-2}$	42768 mg/kg
Carbonate	CaCO3	1.36 %
Chlorides	Cl^{-}	0.102 mg/l
	Nacl	0.167 %

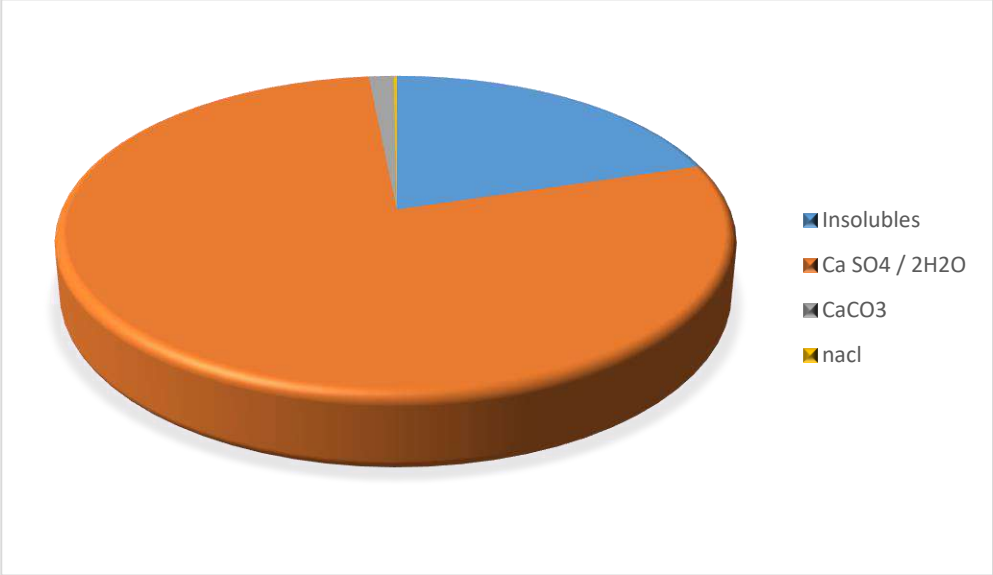


Figure II 8 : Chemical Analysis Result of Traditional gypsum (Timchemt)

The relative circle shows the results of the chemical experiments of Timchemt with 78% sulphate and 20% Insoluble substances ,and 2% carbonate.

f) DRX X-ray diffraction experiment [20]

The objective of an X-ray diffraction experiment is to investigate the intricate structure of matter and to ascertain its crystalline composition. In order to gain a comprehensive understanding of the experimental techniques employed in X-ray diffraction, it is essential to delve into the fundamentals of crystal geometry, the basics of the general description of crystal structure, and the principles of X-ray diffraction. It is crucial to study the fundamental concepts of crystal geometry, the fundamentals of the general description of crystal structure, and the principles of X-ray diffraction.

The fundamental principle of the X-ray machine is based on the following relationship:

$$n\gamma = 2d\sin\theta \quad \text{.....Equation II.4}$$

This equation is known as the BRAGG equation, where :

- $\boldsymbol{n}$: rank diffraction
- $\boldsymbol{\gamma}$: wave length
- $\boldsymbol{d}$: interlayer distance

Wavelength $\boldsymbol{\gamma}$ X-ray diffraction occurs exclusively at a specific angle $\boldsymbol{\theta}$, which determines the spacing (d) between crystalline planes.

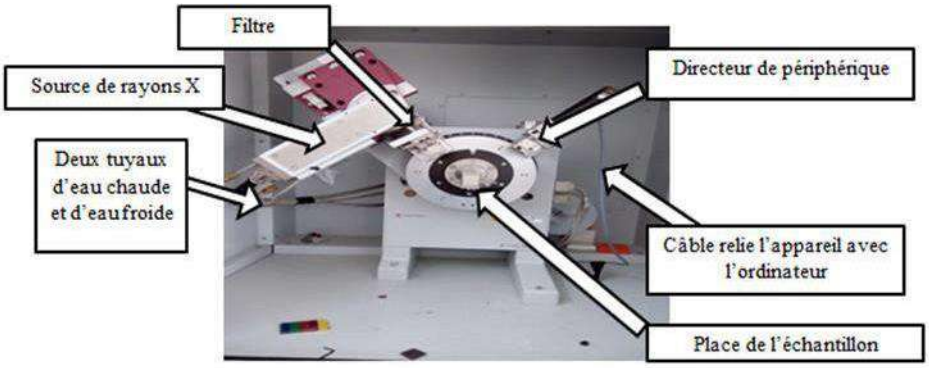


Figure II 9:X-ray diffraction apparatus used in the study

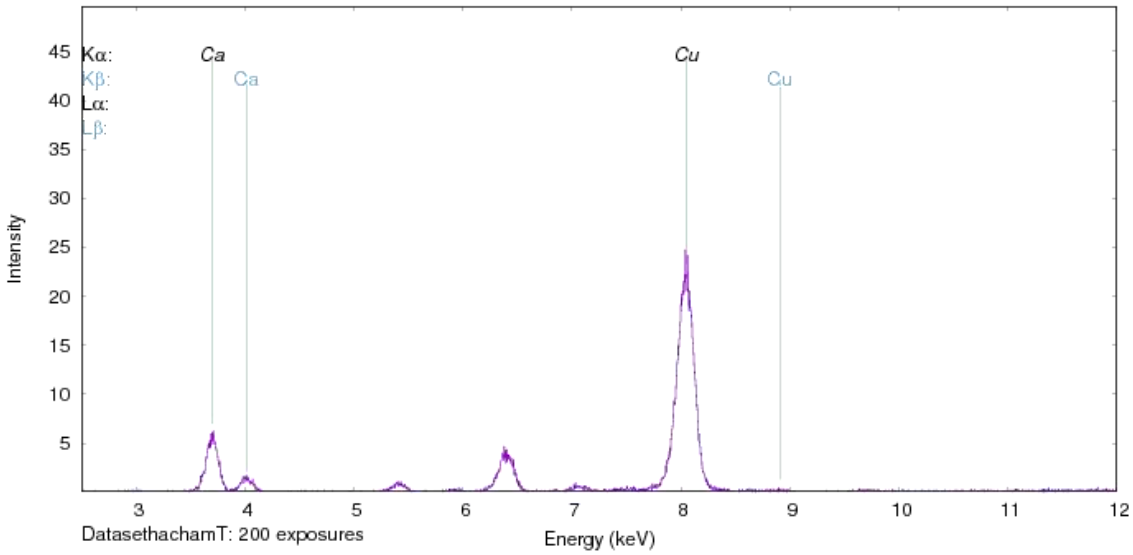


Figure II 10:X-ray Diffraction Curve for Timchemet

The results of this test showed that the studied material is rich in sulphate (73.28%) as the main chemical component, and also consists of (26.72%) of other substances, which confirms the chemical results obtained.

II.2.2.Ciment [22]

Portland cement is a material that exhibits cohesive and adhesive properties in the presence of water, enabling it to bind metal components together and transform them into a monolithic unit.
In this study, Portland cement (ELMATIN) is employed with the following characteristics:

Figure II 11: Cement powder

Table II 4:cement compression

Compression Force	The value
2 days (MPA)	≥ 10.00
28 days (MPA)	≥ 42.5

Table II 5:physical properties

physical properties	The value
Consistence normale %	26.5 ± 2.0
Finesse suivant la méthode de blaine (cm²/g) (NA231)	3700 – 5200
Retrait à 28 jours (µm/m)	< 1000
Expansion (mm)	≤ 3.0

Table II 6:Chemical properties

Chemical Analyses	The value
Perte au feu (NA5042) (%)	10.0±2
Teneur en sulfates (SO3) (%)	2.5±0.5
Teneur en oxide de magnéium MgO (%)	Max 5 %
Teneur en chlorures (NA5042) (%)	< 0.1

Product Benefits

- High initial strength for structures requiring rapid stripping
- Promotes concrete workability and maintains its rheology
- A true class that gives concrete high performance.
- Improved concrete durability.

II.2.3.The gravel

The gravel 3/8 is a coarse, crumbly rock produced by crushing natural rocks using a crushing machine that produces pebbles of varying dimensions, with grain diameters exceeding 2 millimetres. **[23]**

Figure II 12 : gravel 3/8

Table II 7:apparent and absolute volumetric mass of gravel 3/8

The Experiment	The value
Apparent volumetric mass (t/m³)	1.34
Absolute volumetric mass (t/m³)	2.63

Table II 8:Chemical analysis of gravel 3/8

Elements	**The value %**
SO_3	0.253 %
Ca CO3	57.6 %
SiO2	30.4 %
Cl-	0.011 %

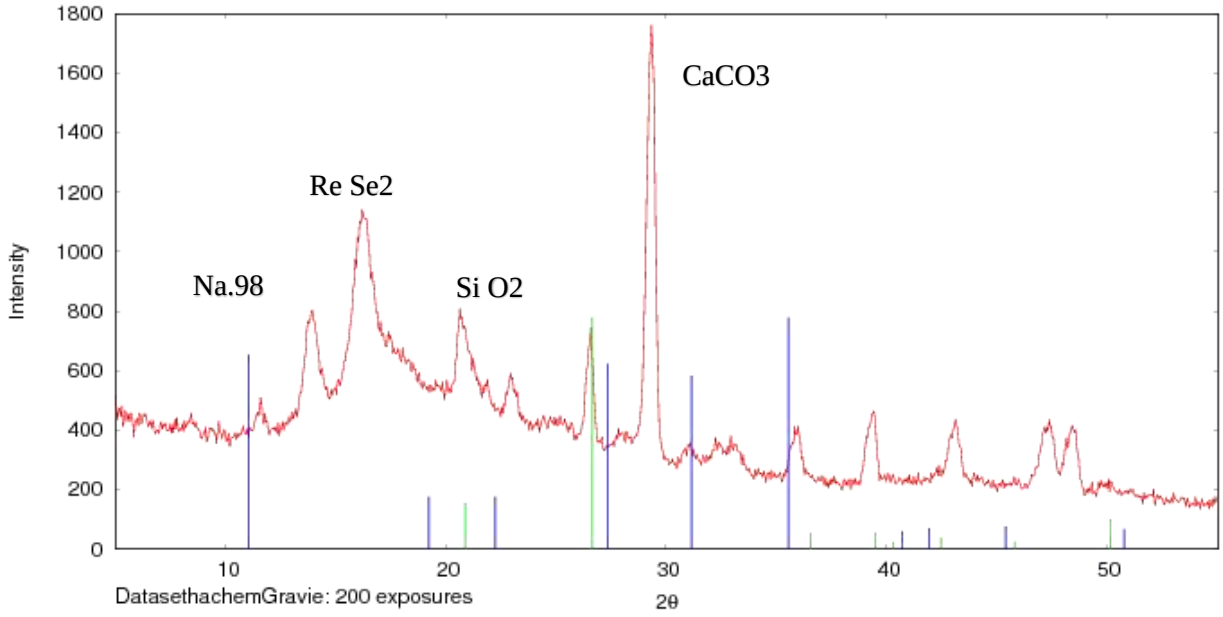


Figure II 13*:* X-ray Diffraction Curve for gravel

The results of this test showed that the material studied is rich in calcium carbonate as the main chemical component, and also consists of other substances such as silicon oxide, which confirms the chemical results obtained.

II.2.4.Glass powder

Figure II 14:Glass powder

To obtain the glass powder, proceed as follows : **[20]**

Bring glass waste.

- Clean the glass and anything else present, even properties of the glass do not change.
- Crush the glass into small pieces and put them in the crusher.
- Put the crushed glass in the crusher for some time.
- sieve glass to sieve 0.08 the remainder is brought back to the crusher and reserves the by-pass

Figure II 15: Steps to obtain glass powder [20]

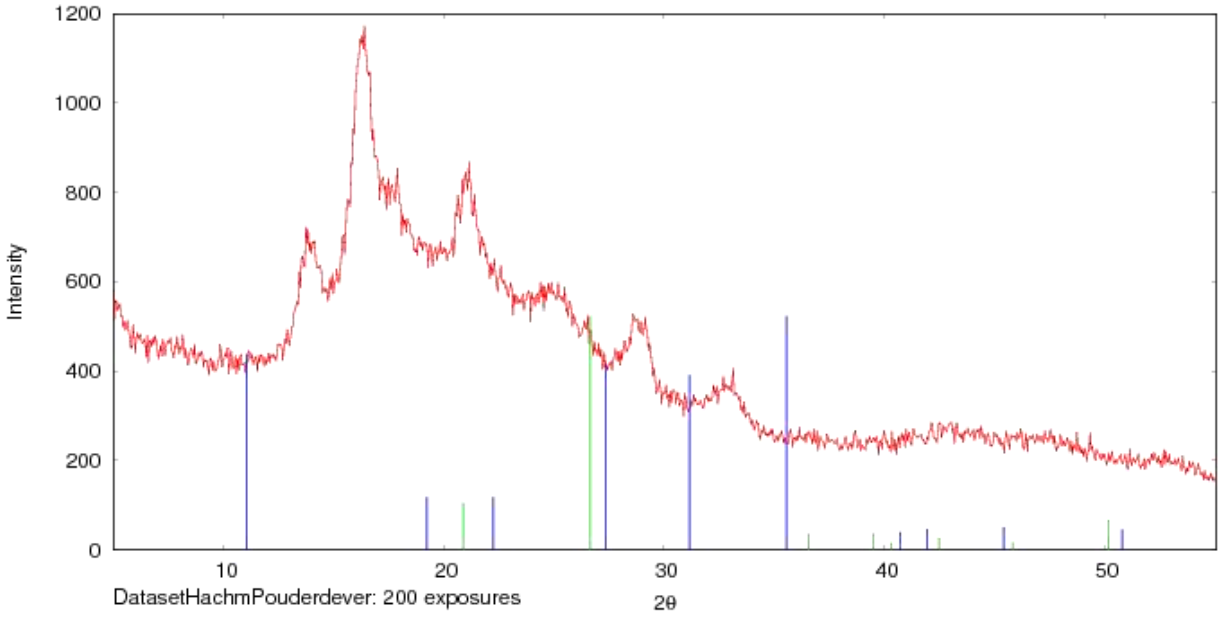


Figure II 16*:* X-ray Diffraction Curve for Glass powder

Table II 9 : Chemical analysis of glass powder [20]

	$SO4^{-2}$	CaCO3	SO_3	CL^-	NaCL	Insolubles
analyse de verre (%)	0.939	0	0.175	0.003	0.006	99.03

II.2.5.water [20]

The water used for the various batches of mortar comes from the concrete laboratory tap at the Department of Civil Engineering and Hydraulics at Kasdi Merbah Ouargla University. It's clean, drinkable water.

Table II 10: Chemical analysis of water

Ca^{++}	Mg^{++}	K^{+}	Na^{+}	Cl^{-}	NH_3	SO_4^{-}	HCO_3^{-}	PH
292.58	26.4	30	200	585.59	/	1156	159.24	6.66

II.3.Conclusion

- According to the physico-chemical experiments applied to traditional gypsum (Timchemt), we conclude that this material contains 26% of coarse grains, 38% of fine grains, 32% of silt and 4% of clay.
- The results of chemical analyses show that traditional gypsum is low in salt but high in calcium sulphate, which means that this material is of gypsum origin.
- The hydraulic binder used is (N 42.5 L-B/II CEM-CPJ) cement available on the market and approved by the Algerian Building Standards.
- The results of chemical analyses show that gravel is high in calcium carbonate.

Chapter III

Explanations and results

III.1.Introduction

In this chapter, we will learn about the mechanical and physical properties through several experiments that show us the properties of traditional gypsum as well as the effect of additives such as glass powder, with a fixed percentage of cement and gravel, and for this purpose we did some mechanical experiments (Compression and bending experiment and Ultrasound test) and physical experiments (Volumetric mass and water absorption experiment).

To help us answer the questions (What is the effect of glass powder on bricks? What is the right mixture to give good resistance to bricks made of traditional gypsum and glass powder?)

It should be noted that all these experiments were carried out at:

- Civil Engineering Laboratory at Kassdi Merbah University (Ouargla)
- Laboratory of Study and Control (LEC).

III.2.Sample preparation method

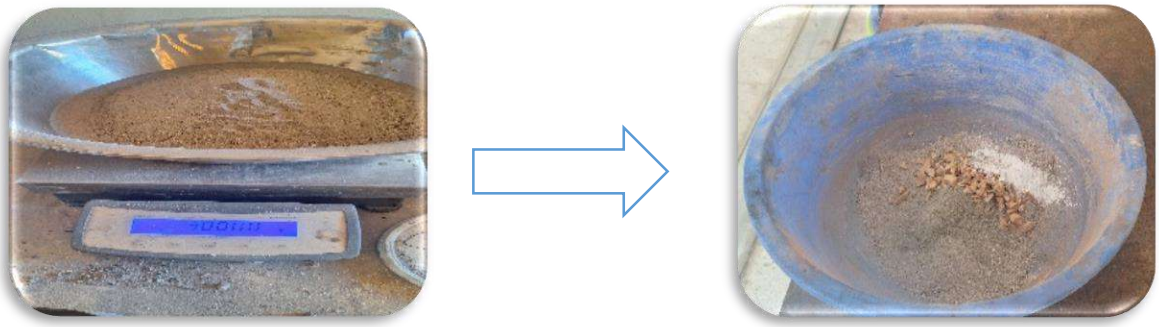
Using the initial weight, six variables (percentage of local gypsum plus percentage of glass powder) were prepared for samples with dimensions of 160 x 40 x 40 x 40 mm^3.

We calculate the weight of glass powder and timchemt for each sample by keeping the percentages of gravel and cement constant and applying the mathematical procedure to find the weight associated with each proportion. then, we determined the compositions' weights using the following formula:

Table III 1: Percentage of composition used

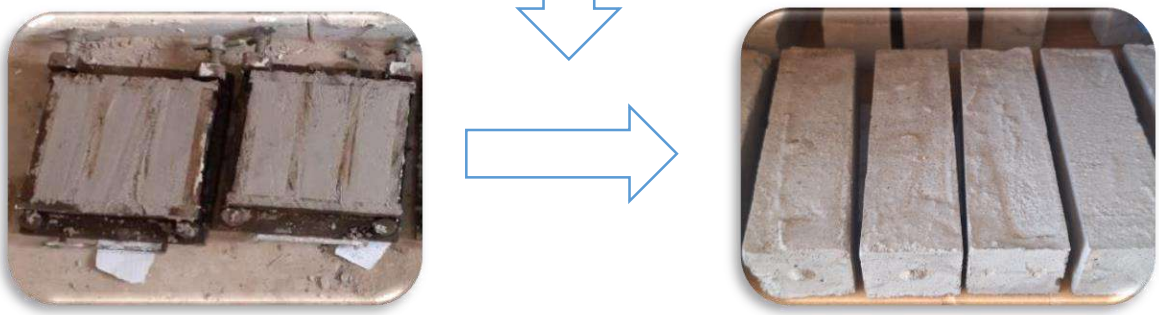
Samples	Percentage of timchemt in the sample	Percentage of glass powder in the sample	Percentage of ciment in the sample	Percentage of gravel in the sample	*Mixing water :*
T70PDV0	70%	0%	5%	25%	36%
T69PDV1	69%	1%	5%	25%	36%
T68PDV2	68%	2%	5%	25%	34%
T67PDV3	67%	3%	5%	25%	33%
T66PDV4	66%	4%	5%	25%	32%
T65PDV5	65%	5%	5%	25%	31%

To prepare samples, we took the following steps :



Weigh the materials: Timchemt, gravel, cement, glass powder, water

Preparing moulds and Mixing the materials



pouring the mixture and storage the sample

Figure III 1 : Sample Preparation Method

III.3.Physical experiments

III .3.1.Volumetric mass

The volumetric mass of bricks according to various ratios of timchemt, gravel, cement, and glass powder are displayed in the following table :

Table III 2:Volumetric mass results

Samples	T70PDV0	T69PDV1	T68PDV2	T67PDV3	T66PDV4	T65PDV5
Volumetric mass (g/cm^3)	1.57	1.55	1.54	1.53	1.51	1.51

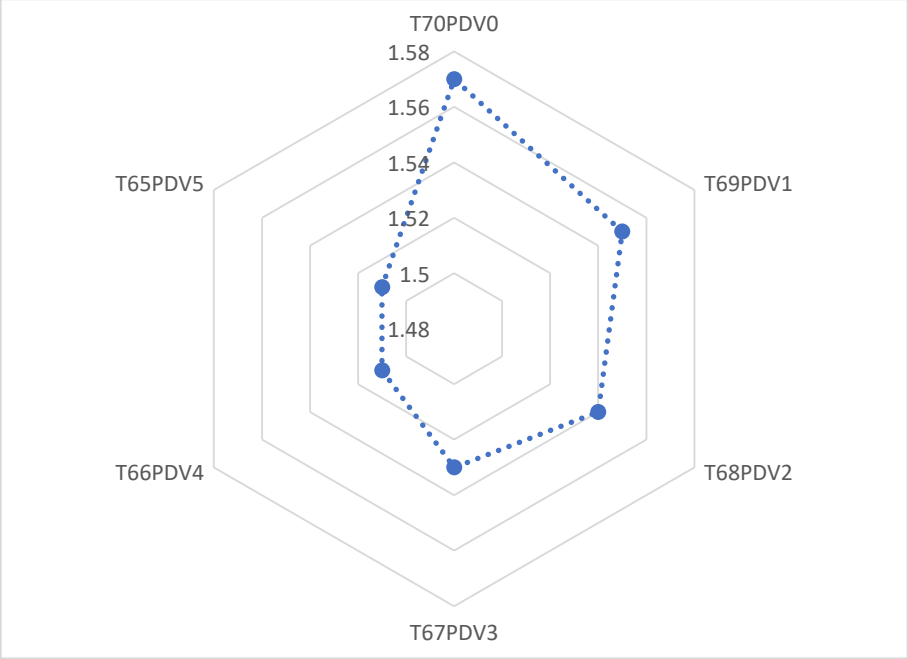


Figure III 2:Volumetric Mass Radar

From the Radar, we can see :

- Sample T70PDV0 has the highest value due to the absence of glass powder in the mixture
- The volumetric mass decreases by 4%
- The more glass powder, the lower the value of volumetric mass, because the volumetric mass of glass powder is less than the volumetric mass of timchemt.

III .3.2.Water absorption experiment (NF EN 772-11)

It is the amount of water absorbed per unit time when only one side of the sample is in direct contact with the distilled water.

The samples are dried at 70°C until a constant mass is obtained. The dry mass is then determined by weighing the samples. Next, the samples are placed in a basin of distilled water to absorb the water in one direction.

The test samples are then weighed at specific times according to the standard used (NF EN 772-11).

$$Cw.s = \frac{mso.s - mdry.s}{As\sqrt{ts.o}} * 10^6 \quad \text{.....Equation III.1}$$

Cw.s : Water absorption coefficient By g/m².$S^{1/2}$

mso.s : The mass of the sample after immersion for time t by g

mdry.s : Sample mass after drying by g

As : the total area of the sample surface immersed in distilled water by mm²

ts.o : Immersion time by S

Figure III 3: Water absorption experiment

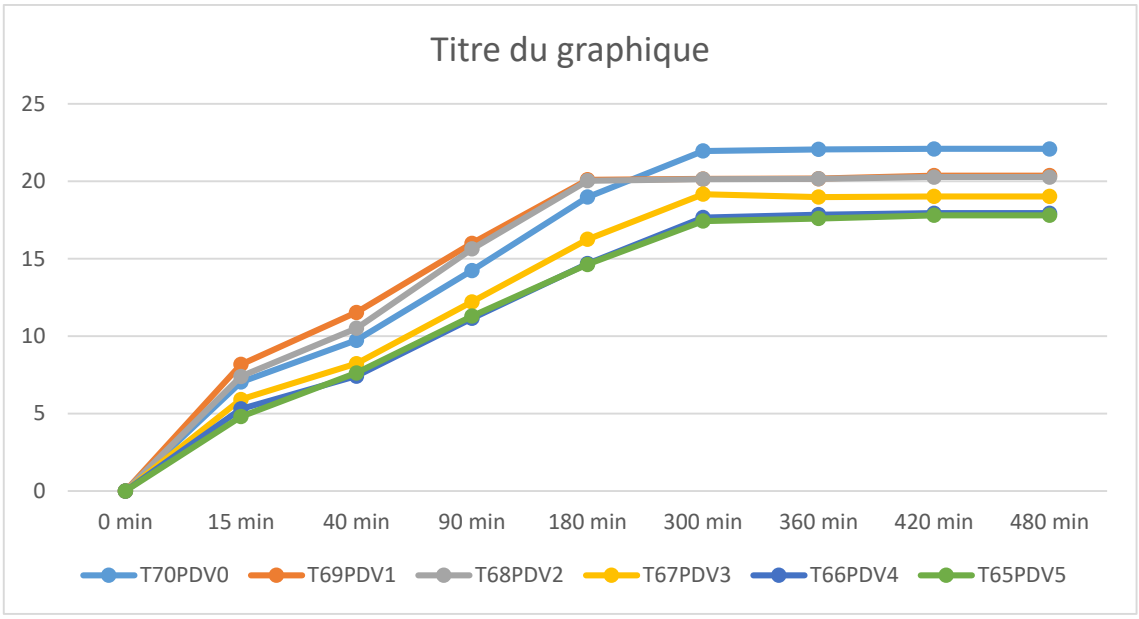


Figure III 4: Change in water absorption coefficient curve over time

From the curve, we notice :

- The absorption coefficient increases until it stabilises at 300 minutes.
- Sample T70PDV0 has the highest percentage of water absorption due to the absence of glass powder and the presence of voids that allow water saturation.
- As the percentage of glass powder increases, the absorption decreases.

III.4.Mechanical experiments

III.4.1.Bending Resistance (NF P15-471)

This test is used to measure the resistance of concrete to deformation when bending forces are applied to it. The specimen rests on three points in The bending machine and a force is applied to it and when it splits, the maximum value is recorded.

Figure III 5: Bending Resistance

Formula used to calculate :

$$\mathbf{Rf} = \frac{1.5\,P\,L}{a^3} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{Equation III.2}$$

Rf: Bending Resistance by MPA

P: Force applied to the sample by N

L: Sample section side length by mm

a: Sample height mm

Table III 3: **Bending Resistance results**

Samples	T70PDV0	T69PDV1	T68PDV2	T67PDV3	T66PDV4	T65PDV5
Bending (Mpa)	1.77	1.82	1.92	1.87	1.82	1.72

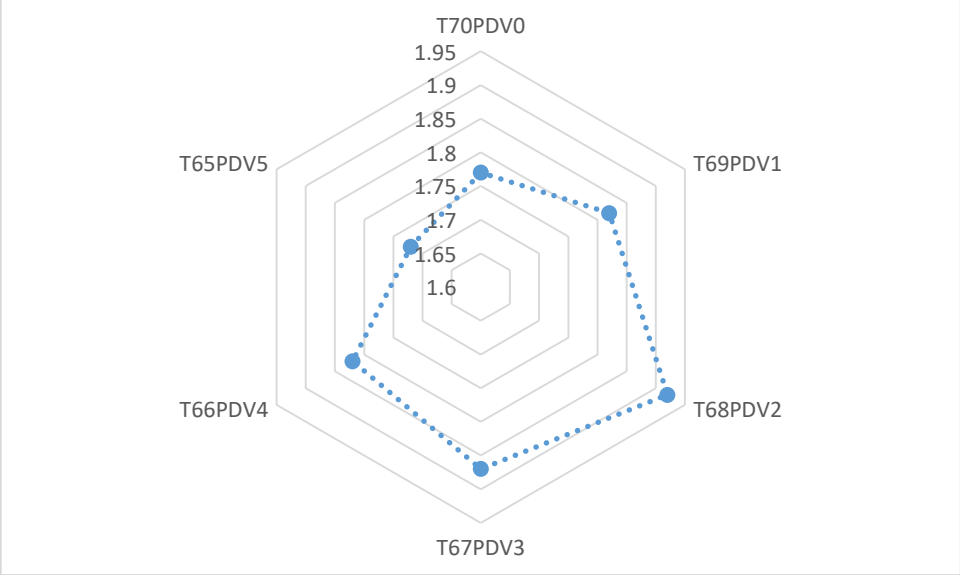


Figure III 6: **Bending Resistance Radar**

III.4.2. compressive resistance (NF P15-471)

The aim of this experiment is to find out the simple compression resistance of the sample, the principle of the experiment is to take a sample and put it in a compression device where we apply a force that makes it collapse, at the same moment of collapse we remove the applied force and read from the device the compression resistance R.

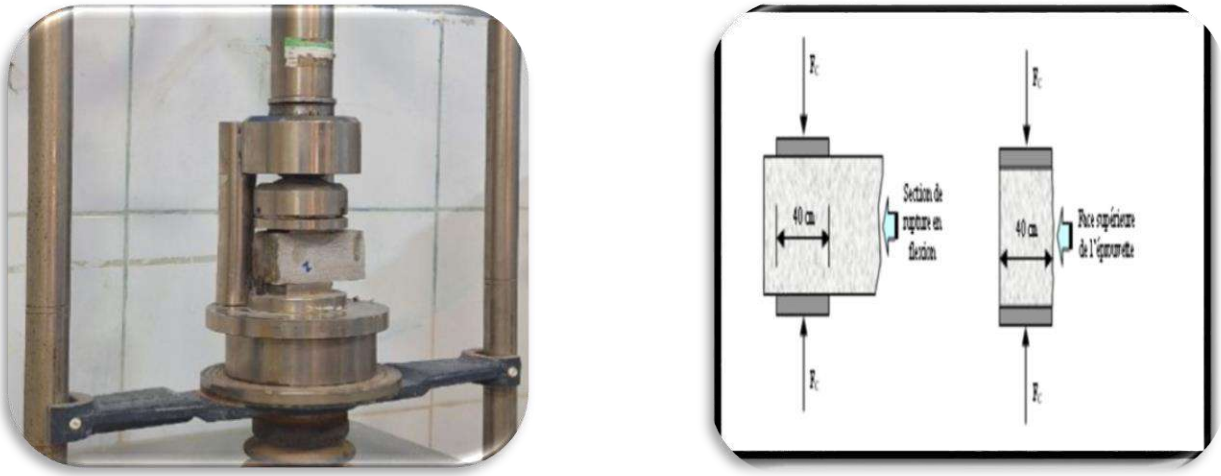


Figure III 7: compressive resistance

Formula used to calculate :

$$Rc = \frac{Fc}{S} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation\ III.3$$

Rc : Compression resistance by MPA

Fc: Pressure applied to the sample by N

S: The area of the sample under pressure by mm

Table III 4: Compression resistance results

Samples	T70PDV0	T69PDV1	T68PDV2	T67PDV3	T66PDV4	T65PDV5
Compression (MPa)	3.67	4.25	4.49	3.86	3.24	2.81

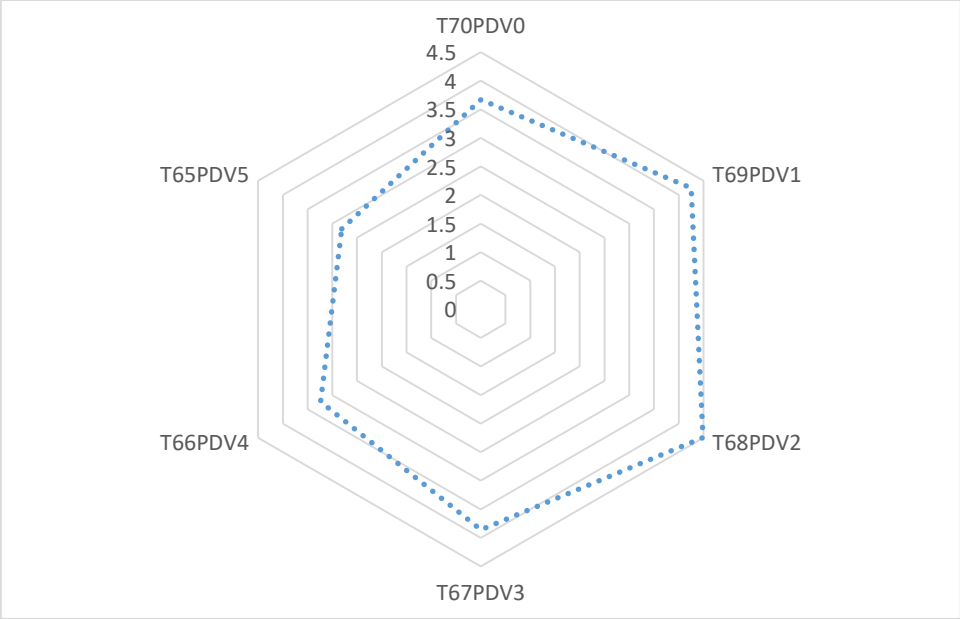


Figure III 8: Compression resistance Radar

According to Figure

there are two stages :

Stage 1:

Bending resistance values increase as the percentage of glass powder increases, up to the sample containing 2% glass powder

Sample T68PDV2 records the highest value due to the presence of glass powder, which plays a a role in the cohesion of the mix, as the glass powder particles fill the spaces between the fibres.

Stage 2:

Bending resistance decreases with increasing percentage of glass powder

After sample T68PDV2, the curve decreases due to the increase in the percentage of glass powder, which played a second role in breaking the cohesion of the mix.

III.4.3.Ultrasound test (NF EN 12504-4)

An electro-acoustic transducer is used to create a longitudinal wave train that is then transmitted through the test specimen. The vibration train is converted into an electrical signal by a second transducer after traveling a known distance through the specimen. Electronic time meters are then used to measure the pulse travel time. Sound velocity measurements can determine sample

homogeneity, the presence of cracks or voids, changes in properties over time, and physical and dynamic characteristics. It is a valuable tool for assessing the quality of a sample.

Figure III 9: Ultrasound test

Formula used to calculate :

$$V = \frac{L}{T} \text{.....} \textit{Equation III.4}$$

V: The conventional propagation speed by m/s

L: the distance between the transducer by m

T: the propagation time by s

Table III 5: Ultrasound test results

Samples	**T70PDV0**	**T69PDV1**	**T68PDV2**	**T67PDV3**	**T66PDV4**	**T65PDV5**
sound speed(m/s)	2303.5	2448	2529	2526.5	2307.5	2264.5

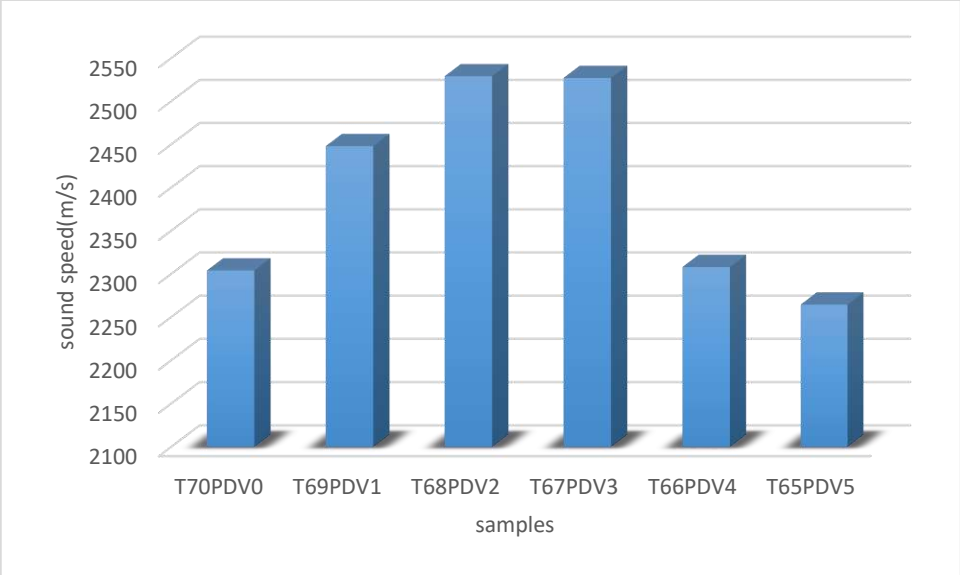


Figure III 10: Ultrasound test Histogramme

According to Figure

there are two stages :

Stage 1

The sound speed value increases as the percentage of glass powder increases by 6 %, with sample T68PDV2 is 2529 m/s having the highest value.

Stage 2

The sound speed decreases as the percentage of glass powder increases by 10 % until it reaches 2264.5 m/s

ultrasound results confirm the results of the mechanical expriments.

III.5.Conclusion

- Sample T68PDV2 with 2% of glass powder gave good results for compressive and bending resistence. and Ultrasonic testing confirmed the mechanical results.
- Addition of glass powder improves mechanical resistence.
- In physical experiments, the higher the percentage of glass powder in the mixture, the lower the absorption coefficient due to the presence of voids.

General Conclusion

In this research, we studied the mechanical and physical properties of traditional gypsum bricks, considered one of the most important building materials in the Ouargla region, in order to improve and valorazion these properties by adding different percentages of glass powder.

According to bibliographic study and the physical, chemical and mechanical tests carried out on the materials studied We talked about :

- The types of concrete blocks (solid, hollow, interlocking, etc.).
- vad-vad block and its advantages and applications.
- We have referred to the recycling and reuse of waste in the production of bricks.
- Timchemt contains 26% of coarse grains, 38% of fine grains, 32% of silt and 4% of clay.
- The results of chemical analyses show that traditional gypsum is low in salt but high in calcium sulphate, which means that this material is of gypsum origin.
- The hydraulic binder used is (N 42.5 L-B/II CEM-CPJ) cement available on the market and approved by the Algerian Building Standards.
- The results of chemical analyses show that gravel is high in calcium carbonate.
- Sample T68PDV2 with 2% of glass powder gave good results for compressive and bending resistence. and Ultrasonic testing confirmed the mechanical results.
- Addition of glass powder improves mechanical resistence.
- In physical experiments, the higher the percentage of glass powder in the mixture, the lower the absorption coefficient due to the presence of voids.

Recommendations

- Limit the study of the effect of adding glass powder to between (1.5%-2%).

-Study to improve the water resistance of traditional gypsum.

References

[1] "Concrete Blocks - Types, Uses, Advantages & Disadvantages." (n.d.), https://www.engineeringcivil.com/concrete-blocks-types-uses-advantages-disadvantages.html

[2] "What is Solid Concrete Blocks? Different types of Solid Concrete Blocks explain in details. Purpose of using Solid Concrete Blocks",(n.d.), https://engineersblog.net/what-is-solid-concrete-blocks/

[3] "Concrete Hollow Blocks – The Ultimate Guide", Chao Zhang , April 30, 2020, https://www.block-machine.net/concrete-hollow-blocks/.

[4] "Interlocking Concrete Blocks." PPC Concrete Products, n.d, https://ppcconcreteproducts.co.uk/interlocking-concrete-blocks/

[5] ",Qt4-16 Full Automatic Sand Brick Vad Habiterra Block Making Machine Qingdao Hf Industrial",(n.d.), https://blockmachine1.en.made-in-china.com/product/BAEpGcbwJJVH/China-Qt4-16-Full-Automatic-Sand-Brick-Vad-Habiterra-Block-Making-Machine-Qingdao-Hf-Industrial.html.

[6] "VAD-VAD GEOMETRIC OMNILOCK"**,**Sergei,(n.d), https://vad-vad.com/.

[7] "Constructing a house using interlockingblocks"**,(n.d), https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DL9uyMVTpK_I&psig=AOvVaw03UGTsFuLJql4Tn7PExndb&ust=1717112407470000&source=images&cd=vfe&opi=89978449&ved=0CBQQjhxqFwoTCNDMxvH2s4YDFQAAAAAdAAAAABAE.**

[8] CHAHMA S. ; « Etude des propriétés Thermo –Mécaniques des briques en terre gypse traditionnel (Temchemt) stabilisée par le ciment ou par la chaux (cas de la ville d'ouargla) 2018

[9] حيدر ب ,محمود ع, "المساهمة في دراسة تأثير أالليف النباتية المعالجة على الجبس التقليدي (تيمشمت) " ,مذكرة تخرج ماستر ، جامعة قاصدي مرباح ورقلة ، قطب 3 ،2023/2022.

[10] BOULIFA M, DEBABI A, " Utilisation de poudre de verre dans le mortier" ,mémoire de master Université d'Ouargla,2017

[11] محمد الدغيري, أستاذ الجغرافية الاقتصادية المساعد قسم الجغرافيا,"النفايات الصلبة: تعريفها - أنواعها وطرق علاجها", جامعة القصيم, (ب.ت) .

[12] "WASTEWOIMA® FUELS – BIO-MEDICAL WASTE",nd, https://woimacorporation.com/wastewoima-fuels-bio-medical-waste/.

[13] Ouahbi Fatima –Rachida. "Étude des propriétés mécaniques d'un mortier à base de déchet de béton et du verre réutilise",,mémoire de master Université d'Ouargla,2022/2023.

[14] "Household Hazardous Waste Collection",(n.d), **https://cceontario.org/**.
[15] "KMC exploring new sites to manage biodegradable waste",(n.d), https://www.nepalminute.com/detail/723/kmc-exploring-new-sites-to-manage-biodegradable-waste.

[16] "DISPOSING OF RUBBLE, HARDCORE & INERT WASTE",(N.D), https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.commercialrecycling.co.uk%2Fwaste-types%2Finert-waste-disposal%2F&psig=AOvVaw33OdoFhh3o1yOcPiYX-DLy&ust=1717116663290000&source=images&cd=vfe&opi=89978449&ved=0CBQQjhxqFwoTCOjr3N-GtIYDFQAAAAAdAAAAABAE

[17] "Glass | Definition, Composition, Material, Types, & Facts", Encyclopædia Britannica,13/05/2024. https://www.britannica.com/technology/glass .

[18] "Float Glass Ultra Clear Th. 4 mm",(n.d), https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.hobbyland.eu%2Feng%2Fshop%2Ffloat-glass-ultra-clear-th-4-mm%2Fp-F003297%2F&psig=AOvVaw3GsPvx55jrPQU9mJez_T7L&ust=1717117015958000&source=images&cd=vfe&opi=89978449&ved=0CBQQjhxqFwoTCJjjrIeItIYDFQAAAAAdAAAAABAK

[19] "WHAT IS GLASS POWDER? ", January 31, 2022, https://bsgglasschip.com/what-is-glass-powder/.

[20] CHEREFEDDINE N , MELOUAH S"ETUDE DE L'INFLUENCE DE L'AJOUTE DE POUDRE DE VERRE SUR LE COMPORTEMENT THERMO-MECANIQUE DES TIMCHEMT", mémoire de master Université d'Ouargla,2019/2020.

[21] أبانو م ,خضير ع , "دراسة خصائص طوب بالمواد المحلية ـ تيمشمت ـ) " ,مذكرة تخرج ماستر ، جامعة قاصدي مرباح ورقلة ، ،2023/2022"..

[22] "Ciment Portland au calcaire",Lafarge Algeria,n.d, https://www.lafarge.dz/sites/algeria/files/documents/fp_new_matine_fr.pdf .

[23]شتيوي ع ,خنفر ر, " *صناعة طوب مصمت على أساس رمال الكثبان والحصى 3/8 ونشارة الخشب* " .مذكرة تخرج ماستر، جامعة قاصدي مرباح ورقلة 2022.

Annexes

50kg

متين MATINE

ALGÉRIE

LAFARGE
Construire
des villes meilleures™

Ciment portland au Calcaire

NA442 CEM II/B-L 42,5 N

Matine Ciment gris pour bétons de haute-performance destiné à la construction des Ouvrages d'Art, infrastructure et superstructure pour bâtiments

Matine
NA442 CEM II/B-L 42,5 N

Matine est certifié, conforme à la norme Algérienne (NA442 – 2013) et Européenne (EN 197-1)

AVANTAGES PRODUIT

- Une résistance initiale élevée pour vos ouvrages nécessitants un décoffrage rapide
- Favorise la maniabilité du béton et le maintien de sa rhéologie
- Une Classe Vraie qui offre une haute performance au béton.
- Meilleure durabilité du béton.

MEMBRE DE HOLCIM

- Favorise la maniabilité du béton et le maintien de sa rhéologie
- Une Classe Vraie qui offre une haute performance au béton.
- Meilleure durabilité du béton.

MEMBRE DE HOLCIM

APPLICATIONS RECOMMANDÉES

- Construction des Ouvrages d'Art, infrastructure et superstructure pour bâtiments
- Préfabrication légère
- Béton de haute performance

FORMULATION CONSEILLÉE

	Ciment	Sable (sec)	Gravillons (sec)		Eau (litres)
		0/5	8/15mm	15/25mm	
Dosage pour béton C25/30	X 1 (50kg)	+ X7	+ X5	+ X4	+ 25 L

Remaque: un bidon = 10 Litres

CARACTÉRISTIQUES TECHNIQUES

• Analyses chimiques	Valeur
Perte au feu (%) (NA5042)	10.0±2
Teneur en sulfates (SO3) (%)	2.5±0.5
Teneur en oxyde de magnésium MgO (%)	Max 5%
Teneur en Chlorures(NA5042) (%)	< 0,1

• Temps de prise à 20° (NA 230)	Valeur
Début de prise (min)	150±30
Fin de prise (min)	230±50

• Composition minéralogique du Clinker (Bogue)	Valeur
C3S (%)	60±3
C3A (%)	8±2

• Résistance à la compression	Valeur
2 jours (MPa)	≥ 10.0
28 jours (MPa)	≥ 42.5

• Propriétés physiques	Valeur
Consistance Normale (%)	26.5±2.0
Finesse suivant la méthode de Blaine (cm²/g) (NA231)	3 700 - 5 200
Retrait à 28 jours (µm/m)	< 1 000
Expansion (mm)	≤ 3.0

Conditionnement: (50kg) / (1000kg)

CONSIGNES DE SÉCURITÉ

1- PROTÉGEZ VOTRE PEAU : Portez les équipements adaptés dans vos chantiers: casques, lunettes, gants, genouillères, chaussures et vêtements de sécurité.

2- MANUTENTION : levez le sac en pliant les genoux et en gardant le dos droit.

MEMBRE DE HOLCIM

LAFARGE ALGÉRIE
Bureau n°02, 16ème étage, tour Geneva,
les Pins maritimes, Mohammadia, Alger.
tél: + 213 (0) 21 98 54 54
Fax: + 213 (0) 23 92 42 94
www.lafargealgerie.com
dz.satisfaction-clients@lafargeholcim.com
Tél: 021 98 55 55

LAFARGE لافارج

GRAVIER CONCASSE 3/8

ESSAIS			NORME D'essai	RESULTATS	CODIFICATION	CRITERE Pour béton hydraulique
					Selon NF P 18-545	
ANALYSE GRANULOMETRIQUE	Tamis	-	NF P 18-560	-	Gr_A et Gr_B et Gr_C	Valeurs limites (Tab 45)
						Tamis: Min - max
		2D		**100**		16: 100
		1,4D		**100**		11,20: 98 – 100
		D		**99**		8: 80 – 99
		D/1,4		**51**		5,71: 25 – 70
		d		**3**		3: 0 – 15
		0,63d		**1**		1,89: 0 - 5
Masse volumique	Absolue	t/m³	NF P 18-555	**2,63**	-	Entre 2.4 et 2.8
	Apparente	t/m³		**1,34**	-	-
	Absorption	%		**1,43**	Ab_A	≤ 2,5
Propreté (Teneur en fines)	%		NF P 18-591	**1,21**	Gr_A et Gr_B et Gr_C	≤ 1,5
Aplatissement	%		NF P 18-561	**23**	Fl_A	≤ 20
Impuretés prohibées	%		NF P 18-545 voir paragraphe 3.43	**0**	-	≤ 0,1
Eléments coquilliers	%		NF EN 933-7	**0**	Cq_A, Cq_B et Cq_C	≤ 10
Los Angeles	-		NF P 18-573	**27,2**	LA_A	≤ 30
ANALYSE CHIMIQUE	Sulfates soluble dans l'eau SO_3^{2-}	(%)	NF EN 1744-1	**0,253**	SA_D	≤ 0,8
	Carbonate $Ca\,CO_3$	(%)	NF T 90-048	**57,6**	-	Essai d'identification
	Insolubles	(%)	NF P 15-461	**30,4**	-	
	Chlorure Cl^-	(%)	NF EN 1744-1	**0,011**	-	≤ 0,02

Commentaire :

- Ce matériau est conforme aux normes pour utilisation en béton hydraulique.

LEC Géosciences
Laboratoire Etudes et Contrôles
30 villas sahariennes E22 Ouargla 30000 Algérie
Tél. Fax : 00213(0)29 703 696
Mail : m_boublal@yahoo.fr
a_benazzouz@yahoo.fr.

RAPPORT D'ESSAI

ANALYSE GRANULOMETRIQUE

NF P 94-056 / NF P 94-057

Client : **N° Projet :**

Projet :

Endroit :

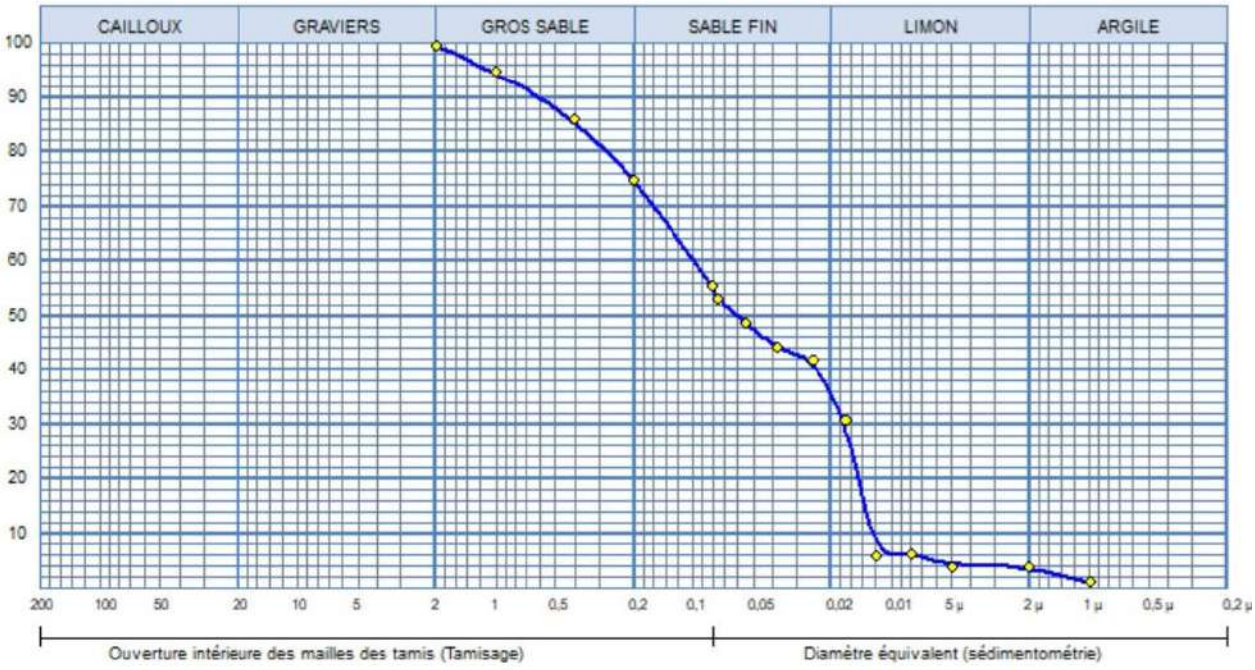
Sondage n° : TIMCHEMTE (1)

Profondeur :

Matériaux :

Provenance :

Date essais :



Analyse Granulométrique		Analyse sédimentométrique	
Tamis (mm)	Tamisat (%)	Diamètre équivalent	Tamisat (%)
2,00	99,48	75,00 µm	53,08
1,00	94,81	55,00 µm	48,65
0,40	86,02	38,00 µm	44,19
0,20	74,95	25,00 µm	41,96
0,08	55,34	17,00 µm	30,81
		12,00 µm	5,95
		8,00 µm	6,29
		5,00 µm	4,06
		2,00 µm	4,06
		1,00 µm	1,13

Echant	< 80 µ	LIMITES D'ATTERBERG			Classificat°
		W.L (%)	W.P (%)	I.P (%)	
—◇—	55,34 %	%	%	0 %	