




Study of the Physical and Chemical Properties of Phosphogypsum Used in the Manufacture of Gypsum Board and Plaster

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ABSTRACT

Phosphogypsum is a by-product of the reaction of sulfuric acid with concentrated phosphate ores to produce phosphoric acid, the latter being the most important acid in the production of all types of phosphate fertilizers. This process takes place in the Iraqi General Phosphate Company in Al-Qaim District, west of Iraq. Phosphogypsum waste is disposed of in large quantities, and the increase and accumulation of this material requires large basins to absorb and preserve; therefore, the use of phosphogypsum in construction industries leads to its disposal. Mineral analyses showed that phosphogypsum is composed of gypsum. Chemically, phosphogypsum consists of (CaO=33.3) (SO₃=44.6) (H₂O=20.05), and the rest of the oxides enter into the sulfate compounds. Phosphogypsum in the present study was used in gypsum board production by adding slime (the by-product of calcining the carbonate part of phosphate raw materials) at a ratio of (90 phosphogypsum: 10 slime), which is called the selected mixture. The suitability of the mixture was evaluated by conducting physical tests, and the results were consistent with the Iraqi standard specifications (ISS, 2015). The mixture was tested by physical tests (compressive strength test (5.51 N/mm²) and fracture criteria (3.295 N/mm²). Phosphogypsum can also be used as a plaster material for interior wall cladding, and the results of the physical tests were consistent with the (ISS, 2015); compressive strength (5.74 N/mm²), fracture toughness (1.937 N/mm²), fineness (5.5-7.5), consistency (18 min), and standard texture (56.8-58.4) %. Mineralogical and chemical analyses were conducted on the approved mixes, which complied with (ISS, 2015). The use of industrial waste, such as phosphogypsum and slime, not only alleviates environmental problems but also provides new resources for the construction industry and reduces the use of natural raw materials.

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دراسة الصفات الفيزيائية والكيميائية لمادة الفوسفوجبسوم المستخدم في صناعة الجبس بورق والجص

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معلومات الارشفة	الملخص
تاريخ الاستلام: 27- نوفمبر - 2024	<p>الفوسفوجبسوم ناتج عرضي لتفاعل حامض الكبريتيك مع خامات الفوسفات المركزة لإنتاج حامض الفوسفوريك، وهو الحامض الأهم في إنتاج جميع أنواع الأسمدة الفوسفاتية. تتم هذه العملية في الشركة العامة للفوسفات العراقية في قضاء القائم، غرب العراق. يتم طرح الفوسفوجبسوم كنفائيات بكميات كبيرة، ويتطلب تزايد وتراكم هذه المادة أحوالاً كبيرة لتخزينها، لذا فإن استخدام الفوسفوجبسوم في الصناعات الإنشائية يؤدي إلى التخلص منه. أظهرت التحاليل المعدنية أن الفوسفوجبسوم يتكون من معدن الجبس. وكيميائياً، يتكون من (CaO=33.3) و (SO₃=44.6 و H₂O=20.05)، بينما تدخل بقية الأكاسيد الرئيسية في مركبات الكبريتات. استخدم الجبسوم الفوسفاتي في هذه الدراسة في إنتاج ألواح الجبس بإضافة مادة السلايم (ناتج عرضي من عملية كلسنة الجزء الكربوناتي في خامات الفوسفات) بنسبة (90 فوسفوجبسوم : 10 سلايم)، وهو ما يُسمى بالخلطة المُختارة. وقُيِّمت ملائمة الخلطة بإجراء اختبارات فيزيائية، وكانت النتائج متوافقة مع المواصفات القياسية العراقية (ISS, 2015)، تم اختبار الخليط عن طريق الاختبارات الفيزيائية (اختبار المقاومة الانضغاطية (5.51 نيوتن / مم²) ومعايير الكسر (3.295 نيوتن / مم²). يمكن أيضاً استخدام الفوسفوجبسوم كمادة ملاطية لأكساء الجدران الداخلية للمباني، وكانت نتائج الاختبارات الفيزيائية متوافقة مع (ISS, 2015)، قوة الضغط (5.74 نيوتن/مم²)، صلابة الكسر (1.937 نيوتن/مم²)، النعومة (5.5-7.5) %، التماسك (18 دقيقة)، والقوام القياسي (56.8-58.4) %. أجريت التحاليل المعدنية والكيميائية على الخلطات المعتمدة، والتي كانت متوافقة مع (ISS, 2015)، إن الاستفادة من النفايات الصناعية مثل الفوسفوجبسوم والسلايم لا يقلل من المشاكل البيئية فحسب، بل يولد ويوفر موارد جديدة لصناعة البناء. ويقلل من استخدام الموارد الخام الطبيعية.</p>
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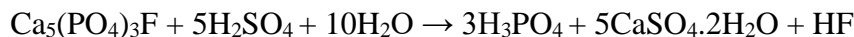
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Introduction

Due to the presence of phosphate industry waste in the General Company of Iraqi Phosphates (slime and phosphate gypsum) in large quantities and the resulting environmental impacts (Fig.1), the idea of recycling these two materials was proposed in a field where the largest possible quantity of them is consumed, which is the field of construction industries. Slime is generally composed of calcium hydroxide (Ca (OH)₂), which is produced by calcining sedimentary phosphate rocks containing carbonates (Ridah, 2017), in the range of 950 - 1000°C, to raise the level of P₂O₅ to more than 25-26 % (Sybtra, 1979a; Abouzeid, 2008). Then it is washed with water and passed through sieves of size less than 40 microns using the wet sieving method to separate the soft slime components from the coarse phosphate materials, which leads to raising the concentration of P₂O₅ to (30-31) %. The slime has a high basic function.

Phosphoric acid, which is the mainstay of phosphate fertilizer production, is produced by reacting sulfuric acid with concentrated phosphate ores. The reaction produces gypsum as a by-product called phosphogypsum (Sybtra, 1979b; Cheng *et al.*, 2020):



The chemical formula of phosphogypsum is identical to the chemical formula of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), so this material can be recycled and used instead of natural gypsum after being dried at a temperature of (150°), as it loses ($3/4$) water molecules and turns into semi-hydrated gypsum (gypsum of Paris), which is more effective than phosphogypsum (Murali and Azab, 2023). When the heating temperature is increased to (230°), the remaining water is lost and converted into anhydrous calcium sulfate (Chistensen *et al.*, 2008), which is known as anhydrite (CaSO_4). The anhydrite can be converted back into gypsum by adding water (Founie, 2003). Phosphogypsum has a low pH (2.37-5.33).

Gypsum board is one of the main application fields of gypsum. When phosphogypsum is used as the main raw material of gypsum in gypsum board, it can relieve the pressure of efficient use of gypsum resources and solve the problem of phosphogypsum waste accumulation. Therefore, under the current strict green and low-carbon environmental requirements and other important factors, phosphogypsum board can be researched and produced (Guedri *et al.*, 2023). The use of phosphogypsum as a Gypsum (plaster) for plastering and finishing buildings is one of the most essential construction industries.

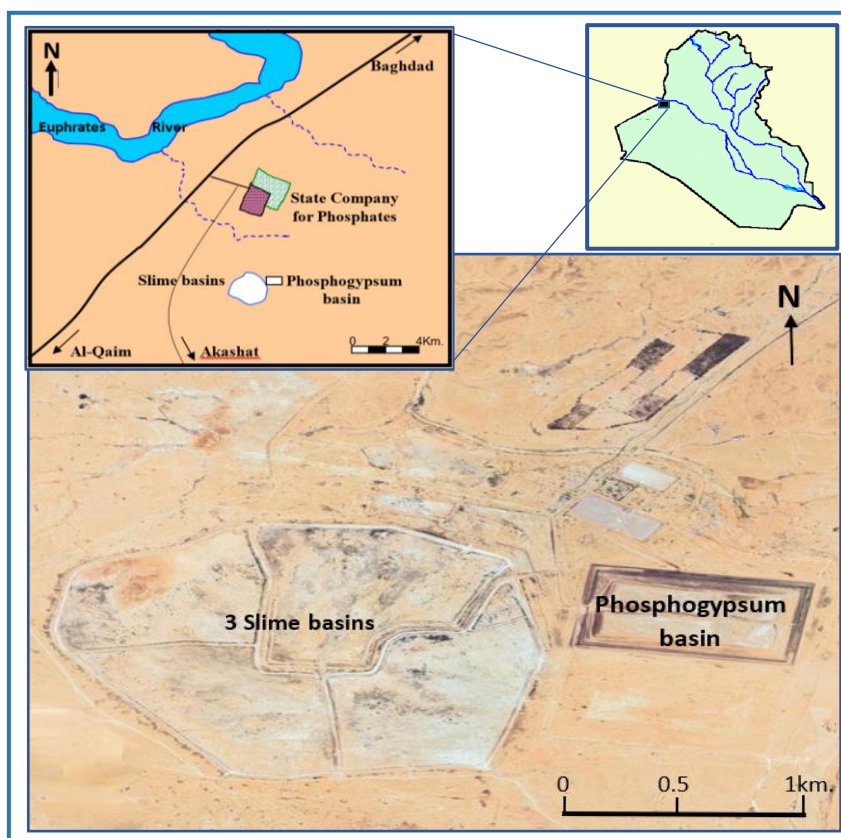


Fig. 1. The location maps of the by-products (phosphogypsum and slime) in the General Company of Iraqi Phosphates.

Sunil (2001) relied on making hollow blocks of lime, phosphogypsum, and fly ash for walls and determining the compressive strength, water absorption, and weight amount that allows the scope of using phosphogypsum in other fields. Phosphogypsum has been used in glass-reinforced gypsum boards. It has been observed that phosphogypsum binder is suitable for making masonry plaster by the mixture (phosphogypsum: sand) with a ratio of 4:1, which

gives a compressive strength of 3.5-4.5 MPa (Singh, 2012). A study by Naik *et al.* (2014) showed that bricks made of gypsum phosphate, cement, and fly ash can be used in construction industries based on the results of physical tests, in addition to their use in construction industries as a plaster (gypsum) material used for plastering and finishing. Bandgar *et al.* (2016) and Yadav *et al.* (2024) studied the benefit of using phosphogypsum in ordinary Portland cement mixtures by significantly delaying the setting time. Phosphogypsum can be used economically up to five per cent as a component or admixture for cement plaster mixes, for both stone and brick construction. The optimum percentage of phosphogypsum to be added to concrete is 7.5%. Srinivasalu and Raghava (2017) pointed out that compressive strength is the most important measure of hardened concrete. The phosphogypsum content that will provide the highest strength to concrete can be found by testing several phosphogypsum additives of 0.5%, 5%, 7.5%, and 10%. It was observed that phosphogypsum in partial form can be used to make very strong and hardened concrete for commercial use when used instead of cement. Murali and Azab (2023) pointed out that storing phosphogypsum for long periods can lead to contamination of soil and groundwater after rainfall, surface water, and groundwater. Weiksnar and Townsend (2024) indicated that the processing of phosphate ore through the wet process to produce phosphoric acid is a common practice in the production of fertilisers, cleaning products, and food additives worldwide and results in a by-product of calcium sulfate known as phosphogypsum.

The study aims to estimate the physical and chemical properties of gypsum boards and plaster used as construction materials that have been manufactured from phosphogypsum and compare their specifications with Iraqi standard specifications (ISS, 2015).

Materials and Methods

The phosphogypsum material was taken from its storage basin at a depth of about 20 cm, to avoid the dust layer covering the phosphogypsum material in the basin. As for the slime material, it was taken from the slime basin in the same way as above.

Phosphogypsum was used in making gypsum board by adding slime to it in specific ratios (10, 20, 30, and 40 %) and pouring it into rectangular molds (2*2*8cm) in the case of examining the fracture criteria. Cylindrical molds with a diameter of 3.5 cm and a height of 5 cm were made to test the compressive strength. The compressive strength and fracture modulus were calculated according to the following equations:

$$R= 3PL / 2bd^2 \dots\dots\dots (1)$$

R: Fraction Criteria

P: Maximum Load

L: Span Length

b: Width of Specimen

d: Depth Specimen

$$\text{Compressive Strength} = \text{Load (N)} / \text{surface Area (mm}^2\text{)} \dots\dots\dots(2)$$

$$\text{Surface Area of Cylinder} = \pi r^2$$

Phosphogypsum is also used as a basic material for producing plaster. Because phosphogypsum is a white, highly fine material, it does not require any additives. Phosphogypsum is prepared by heating it at a temperature of 150° C for two hours, turning it into semi-hydrated calcium sulfate, which is more effective than hydrated calcium sulfate. The best mixing of phosphogypsum and water is with a ratio of 1:1, which is equivalent to 100

g/100ml. The dough is formed and poured into cylindrical molds (3.5*5cm) in the case of testing the compressive strength according to the ISS (2015), and left to dry. When the shiny surface layer of the dough dries, it is evidence of initial solidification (Craig et al., 2004). The heat emission from the mixture, the possibility of the mold separating, and the state of cohesion help determine the final state of hardening. Engineering tests were conducted (strength test, fracture standard, hardening time, fineness, standard consistency). The hardening time was measured by a Vicat device. The tests were conducted in the College of Engineering / Department of Civil Engineering / Materials Testing Laboratory / University of Mosul according to (ISS, 2015).

The mineralogical analysis of both the plaster and the gypsum board of the best mixture (90:10) was performed by X-ray diffraction technique in the National Center for Structural Inspection in Baghdad; the identification of minerals was done according to the standard methods adopted by the center.

The main oxides of phosphogypsum, slime, plaster, and the selected mix of gypsum board (SiO₂, TiO₂, Al₂O₃, Fe₂O₃, CaO, MgO, Na₂O, K₂O, P₂O₅, SO₃) were analyzed by X-ray fluorescence technique in the German laboratory of the Department of Earth Sciences - College of Science - University of Baghdad.

A slide was made for both the plaster and the gypsum board (selected mix) at the University of Tehran for petrographic study.

Results and Discussion

Phosphogypsum and Slime Chemistry:

Table 1 shows the chemical analysis of phosphogypsum and slime, which are the raw materials for producing the mixtures. Calcium oxide and sulfur trioxide are the main components of phosphogypsum, CaO (33.3%-32.5%) and SO₃ (44.60-46.6%), while CaO is the main component of slime, about (57.1%-58.1%).

Table 1: Chemical analyses of phosphogypsum and slime in the present study.

Oxides (Wt%)	Phospho-gypsum 1	Phospho-gypsum 2	Slime 1	Slime 2
SiO ₂	0.54	0.41	2.85	2.85
Al ₂ O ₃	0.01	0.01	0.6	0.64
Fe ₂ O ₃	0.01	0.01	0.32	0.33
CaO	33.3	32.5	57.1	58.1
MgO	0.01	0.01	1.04	1.06
Na ₂ O	0.06	0.05	0.29	0.30
K ₂ O	0.03	0.01	0.02	0.07
TiO ₂	0.01	0.01	0.04	0.04
MnO	0.01	0.01	0.01	0.01
P ₂ O ₅	0.38	0.37	12.1	12.25
SO ₃	44.60	46.60	2.25	2.22
CO ₂	0.00	0.00	7.19	6.21
Cl	0.01	0.01	0.05	0.05
F	0.35	0.33	1.22	1.30
H ₂ O ⁺	20.05	18.72	4.13	4.23
Total	99.37	99.05	99.74	100.22
O=Cl+F	0.15	0.14	0.52	0.56
Total	99.22	98.91	99.21	99.66

Petrography of gypsum board:

Petrographic examinations of the mixture indicate that it consists mainly of gypsum crystals with the presence of some large grains of phosphate components in a very small proportion coming from the slime material mixed with the mixture (Fig. 2). The presence of these phosphate components is the reason for the passage of some of these components during the wet sieving process (to separate the phosphate grains from the calcium hydroxide (slime)) due to the presence of some holes in the separation sieves that led to the transfer of some

phosphate components to the slime material. As for the cement material, it appears in the form of a mixture of gypsum and lime materials according to the mixing ratios.

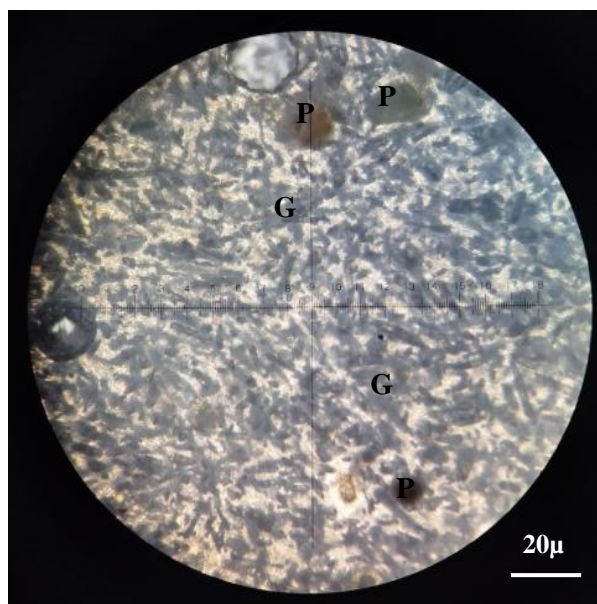


Fig. 2. The crystals of gypsum (G) and phosphatic grains (P) in gypsum board.

Mineral composition of gypsum board:

Mineral analyses of the gypsum board mixture indicated the presence of gypsum phase as the main mineral (Fig. 3).

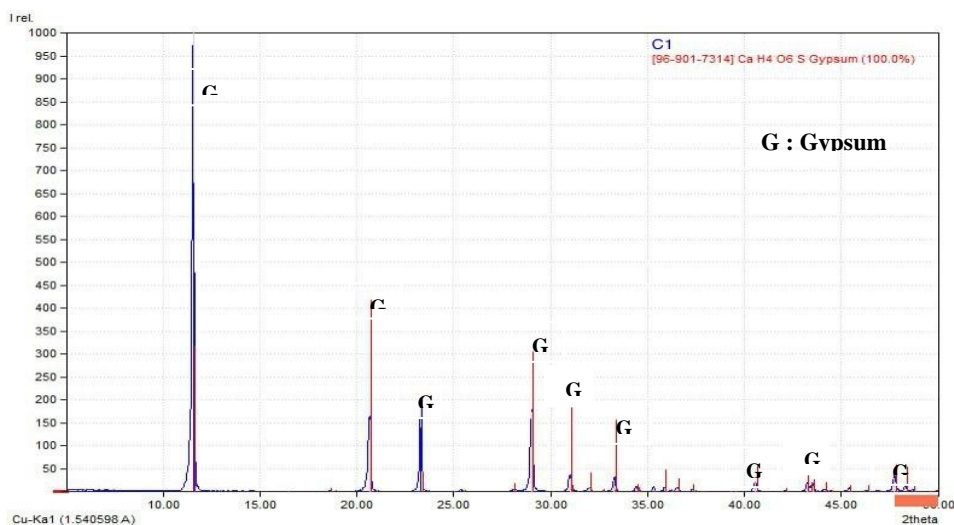
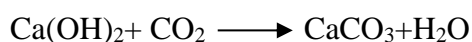


Fig. 3. XRD diagram of gypsum board.

Chemistry of gypsum board

The chemical analyses of gypsum board for the main oxides (CaO), (SO₃), (37.97), (41.64) respectively (Table 2). The ratio (CaO/SO₃) for calcium sulfate is (0.912), which is higher than the default ratio (0.70), indicating the presence of some impurities, including calcite or other calcium phases affiliated with it, which work to raise the ratio of (CaO) versus lowering the ratio of (SO₃), and this is due to the presence of slime material at a rate of (10%) in the mixture. The presence of calcite as impurities is attributed to the fact that during the calcining process of carbonate, limestone grains remain unaffected by the calcining process or as a result of the reaction of Ca (OH)₂ with atmospheric CO₂, forming CaCO₃, which is excreted with the slime, as in the following equation:



The presence of some phosphate granules within the components of the slime (as mentioned previously) led to the presence of P_2O_5 at a concentration of 4.98 wt%. As for (Na_2O), it is attributed to the oxides released from the calcination of the clay part through the calcination process of raw materials, so it goes with the slime, while the rest of the oxides appear as impurities within the phosphogypsum in sulfate compounds. The percentage of loss on ignition (11.67) wt%, which represents the combined water at a rate of (10.11) wt% in the phosphogypsum portion of the mixture, and the remaining percentage is due to CO_2 , which represents the carbonate portion in the amount of slime in the mixture.

Table 2: Chemical analyses of gypsum board and plaster in the present study.

Oxides (wt%)	Gypsum board	plaster	Iraqi Standard Specification (chemical) No. (28 of 2010/Amendment No. 10 of 2015).		
			Regular plaster	Bourke	Artistic plaster
SiO_2	0.53	0.76			
TiO_2	0.01	0.01			
Al_2O_3	0.01	0.01			
Fe_2O_3	0.02	0.01			
CaO	37.97	35.26	>23.3	>30	>26.6
MgO	1.28	1.14			
Na_2O	0.71	0.74			
K_2O	0.06	0.04			
P_2O_5	4.98	3.42			
SO_3	41.64	38.37	>35	>45	>40
Cl	0.02	0.03			
Combined water (%)	10.11	19.25	<9	4 – 9	<9
L.O.I (%)	11.67	19.25	<9	---	<9
Impurity ratio (insoluble silica and clays)	0.57	0.79	---	5	---

Physical properties of gypsum board:

The best mixture for using slime with phosphogypsum was chosen at a ratio of 90:10. The compressive strength values of gypsum board are within the provisions of the Civil Code (No. 28 of 2010/Amendment No. 10 of 2015). The ratio (70:30) gave compressive strength and fracture modulus results of (4.77 N/mm²) (1.677 N/mm²) respectively, which is close to the compressive strength values of the ratio (90:10) as in Table (3), paving the way for using the ratio (70:30) to make gypsum board as a commercial product because it uses the largest possible amount of slime waste. As for the ratio (60:40), its compressive strength was (23.37 N/mm), which is consistent (ISS, 2015), while the fracture standard value was (1.314), which is considered non-conforming (ISS, 2015); therefore, this mixture is not approved as a commercial product. As for the ratio (50slime:50phsphogypsum), the compressive strength and fracture modulus were (2.60 N/mm²) and (0.556 N/mm²), respectively, which is not consistent with (ISS, 2015), (Table 3 and Figures 4 and 5).

The reason is that increasing the percentage of slime leads to a decrease in the amount of water added to the mixture, because the chemical composition of slime includes water Ca (OH)₂. Therefore, the setting time increases to 20 minutes with increasing slime content, and decreases with increasing phosphogypsum content. It is noted that slime absorbs less water than phosphogypsum, but the latter has a faster setting capacity than slime.

Table 3: Physical properties of gypsum board in the present study.

Mix ratios	Phospho-gypsum.	Slime	Compressive strength (N/mm ²)			Fraction modulus (N/mm ²)			
			1	2	Aver.	1	2	3	Aver.
90/10	90	10	5.784	5.235	5.51	3.388	3.291	3.205	3.295
80/20	80	20	5.002	5.113	5.06	1.953	1.874	1.799	1.875
70/30	70	30	4.908	4.622	4.77	1.591	1.694	1.745	1.677
60/40	60	40	3.401	3.346	3.37	1.279	1.365	1.298	1.314
50/50	50	50	2.247	2.962	2.60	0.524	0.548	0.597	0.556

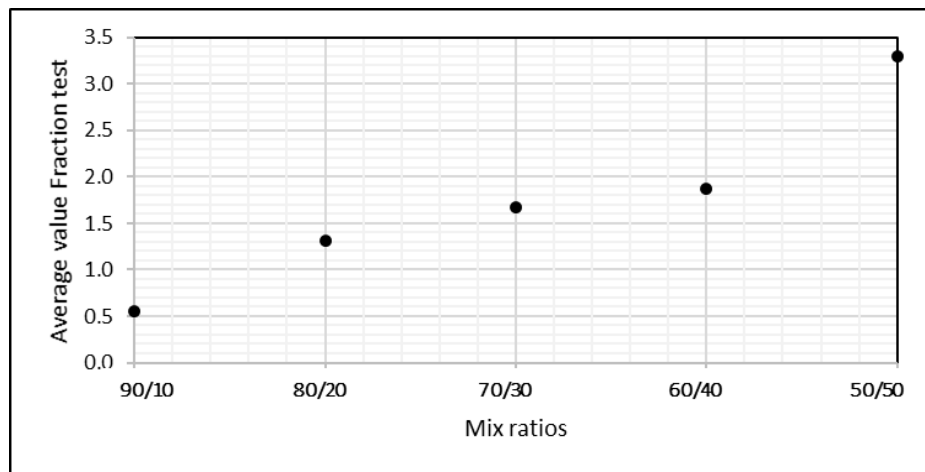


Fig. 4. Fracture coefficient of gypsum board

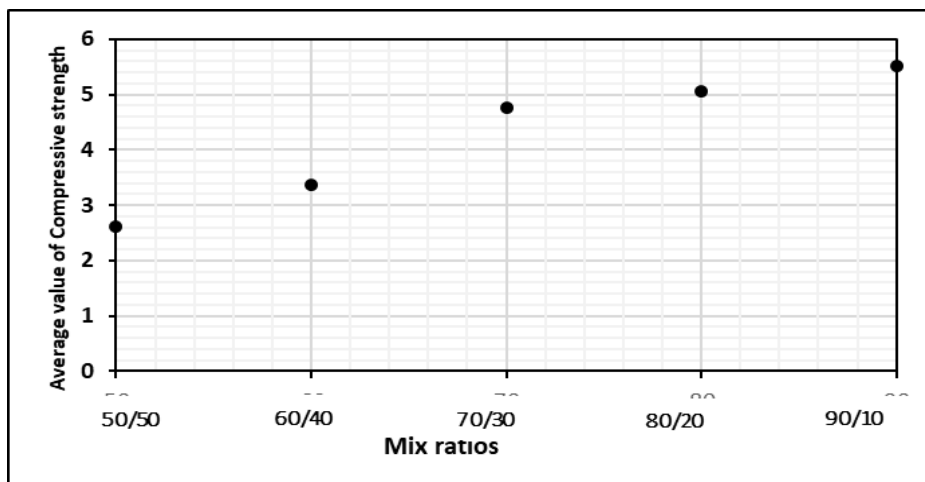


Fig. 5. Compressive strength of gypsum board

Petrography of plaster:

The crystals of phosphogypsum waste appear in the form of needle-shaped crystals of gypsum. The lengths of gypsum crystals range around (10 μ), and the binding cementitious material is also gypsum, as shown in (Fig. 6).

Mineral composition of plaster:

XRD analysis indicates that phosphogypsum is mainly composed of gypsum mineral, as shown in Fig. 7).

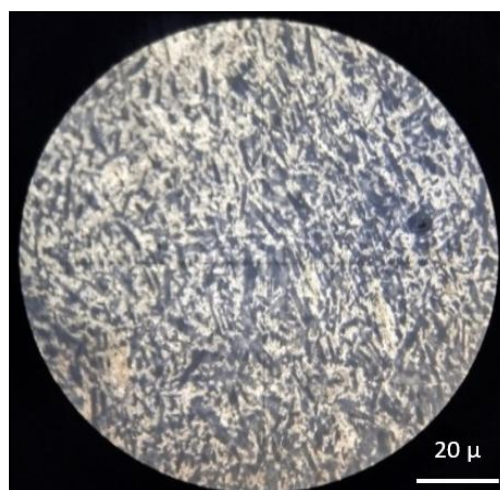


Fig. 6. Gypsum crystals in plaster.

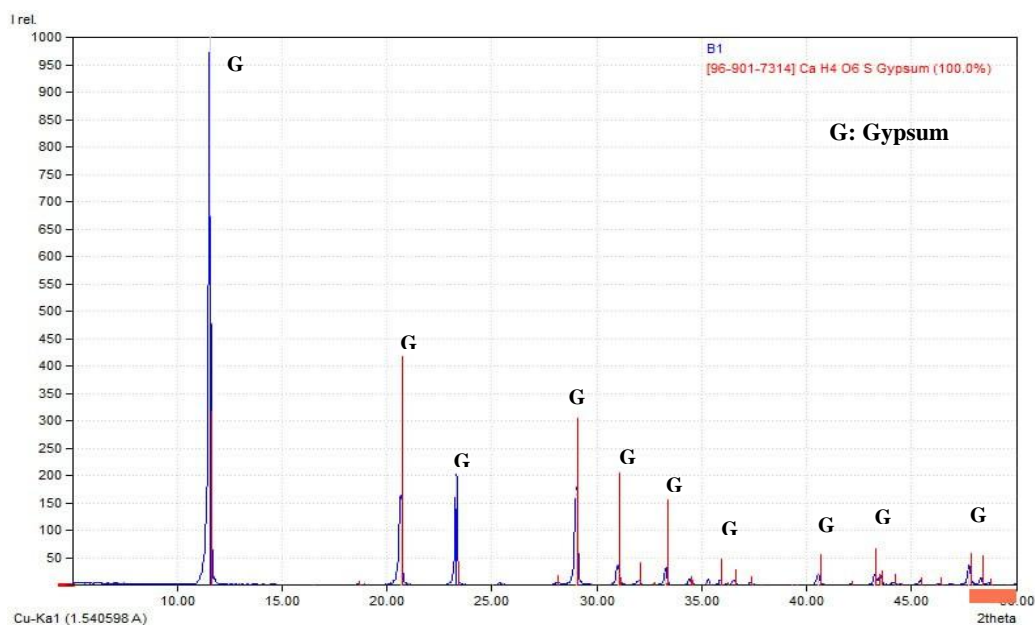


Fig. 7. XRD diagram of plaster.

Chemistry of Plaster:

The chemical analysis of the oxides was conducted to verify the validity of the phosphogypsum analysis and its conformity with the specifications of regular gypsum and its use as a coating material (*plaster*); it was found that the percentage of the substitute phosphogypsum was (84.94) (Hammadi, 2002), and this percentage is good for producing high-quality plaster; as it should not be less than (80) % (Xiao et al., 2022).

The concentration of (SO₃) and (CaO) reached (38.37) % (35.26%) respectively in gypsum, which is consistent with (ISS, 2015) (Table 2), where the percentage of (SO₃) should not be less than (35) %, and the amount of (CaO) should not be less than 23%.

Increasing the proportions of calcium oxide (CaO) and sulfur trioxide (SO₃) leads to a decrease in the water of crystallisation. When calcining at (150°C) for phosphogypsum, we notice that the percentage of water decreases and is accompanied by an increase in the proportions of both (CaO and SO₃). This is evidence of the negative correlation between (CaO and SO₃) and (H₂O) (Wang *et al.*, 2024). As for the rest of the oxides (Al₂O₃, Fe₂O₃, MgO, SiO₂), the total percentages were 1.92 %. These oxides are considered impurities, and this percentage is consistent with the ISS (2015), which should not exceed 5% (Table 2).

The ratio of K₂O and Na₂O indicates the oxides released from the calcination of clay minerals accompanying the phosphate ores. A small percentage of P₂O₅ in the mixture (3.42 wt%), which is attributed to the replacement of PO₄³⁻ with SO₄²⁻ during the reaction of sulfuric acid with the concentrated ores and the formation of phosphogypsum (Xiao *et al.*, 2022).

The percentage of loss on ignition represents the combined water content in the gypsum mineral in the plaster, which is 19.25 wt%. It is worth noting that the difference in the combined water concentration compared to the chemical requirements in (ISS, 2015) is because combined water represents the addition of water to the paste, where the water combines with the calcined gypsum particles to form CaSO₄·2H₂O. Therefore, the combined water percentage is close to the default percentage of water in the gypsum mineral, which is 21%. Meanwhile, the combined water concentration in the chemical specification of (ISS, 2015) represents the amount of water in the calcined gypsum, which is half a water molecule (CaSO₄·0.5H₂O).

Physical properties of plaster:

Compressive Strength is the highest pressure-bearing force on the upper and lower surface areas of the sample. The compressive Strength value of the plaster ranged between

(N\mm² 4.1-5.36) N/mm² and is consistent with (ISS, 2015), which is not less than (3 N\mm²) in regular plaster, and not less than (5 N\mm²) in Bourke. Therefore, there is a relationship between compressive strength, porosity, and the percentage of added water, with compressive strength increasing as porosity decreases. Since gypsum phosphate reacts with water at a ratio of 1:1, increasing water leads to increased gaps (porosity), which are weak points, and thus reduces compressive resistance—that is, an inverse relationship: the higher the density, the greater the resistance. As for the fineness test, it ranged between (5.5-7.5), while it does not exceed (8%), it is within (ISS, 2015) (Fig.8), which indicates that it is free of clumped crystals caused by moisture and impurities.

Water is the medium of interaction of all the dough particles to obtain a standard consistency for gypsum (plaster) with a ratio that ranges between (56.8-58.4) % (Table 4), it is within the ideal water/plaster ratio (upper limits for finish) of (40-60%) (ISS, 2015). When mixing calcined phosphogypsum with water to form a dough, the water chemically combines with (CaSO₄·0.5H₂O. It returns to the original composition of gypsum (Founie, 2003). As for the setting time, it reached 18 minutes, which is within the range (ISS, 2015), which does not exceed 25 minutes. When examining the gypsum's modulus of fracture, the ratio ranged between (1.47-1.93), meaning it is consistent with (ISS, 2015), which falls within the borax classification closest to technical gypsum (Tables 4 and 5) and (Figure 8). The final results showed that increasing the fineness led to an increase in the standard consistency, increased resistance, and fracture strength because it reduced the water used in the dough and reduced voids within the product.

Table 4: The physical properties of the plaster in the Present study.

Fineness % (Sieve No. 16)	Setting time (minutes)	Standard consistency %	Compressive strength (N/mm ²)	Fracture strength test (N/mm ²)
5.5	18	56.80	4.47	1.65
7		58.40	5.74	1.94
7.5			5.36	1.77

Table 5: Iraqi Standard Specifications (Physical) No. (28 of 2010/Amendment No. 10 of 2015).

Properties	Regular plaster	Bourke	Technical plaster
Fineness (%): The remainder does not exceed sieve number (16)	8	---	5
Setting time (min): Not less than and Not more than	8 - 25	8 - 25	12 - 20
Compressive strength (N/mm ²)	>3	>5	>6
Fraction criteria (N/mm ²)	---	>1.5	>2

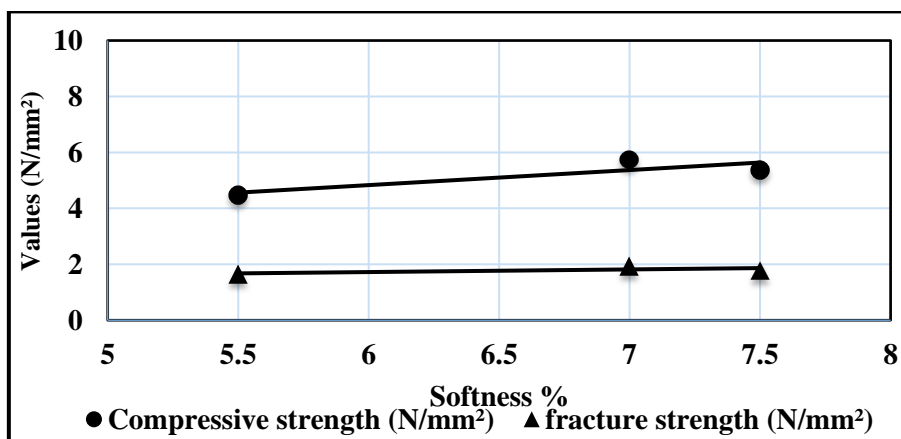


Fig. 8. Physical properties of plaster in the present study.

Conclusion

The study demonstrated the suitability of phosphogypsum for the manufacture of gypsum boards, low-cost sub-ceilings, and gypsum wall coating materials (plaster), as it complies with the Iraqi standard specifications (ISS, 2015). Phosphogypsum is characterized by high quality

and can be used as an alternative to local gypsum based on its mineral, chemical, and physical specifications. Phosphogypsum is composed of the mineral gypsum and chemically ($\text{CaO} = 33.3\%$), ($\text{SO}_3 = 44.6\%$), and ($\text{H}_2\text{O} = 20.05\%$), while the remaining oxides are sulfate compounds.

Adding the slime material at a ratio of (90 phosphogypsum: 10 slime) gave engineering specifications compatible with the Iraqi standard specifications in terms of compressive strength and fracture modulus of (5.51 N/mm^2) and (3.295 N/mm^2), respectively. Given the similarity of the compressive strength values and fracture modulus of the mixture (70:30) with the previous values, the study deemed it possible to use this ratio for the mixture because it achieves greater use of the slime material intending to consume the largest possible quantity of this waste with a low production cost, less effort and high quality, which provides the opportunity to enter into other construction industries.

Phosphogypsum can also be used as a plastering material due to its chemical and engineering suitability in terms of compressive strength (5.74 N/mm^2), fracture modulus (1.937 N/mm^2), fineness (5.5-7.5)%, setting time (18 min), and standard consistency (56.8%-58.4)%.

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