COMPRESSIVE STRENGTH OF MIXES WITH DIFFERENT PROPORTIONS OF PLASTER TO STONE [+]

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Abstruct :

Dental plaster and stone are widely used in dentistry especially in prosthodontics. A mixture of stone and plaster may be used for filling the upper half of the flask during construction of complete dentures .In this study the compressive strength of seven ratios of stone to plaster (S/P) were measured [1:1 , 1:2 , 1:3 , 1:4, 2:1 , 3:1 , and 4:1] . The water/powder ratio was 40:100 for all combination. According to the experimental data , samples of stone to plaster in the ratios of 1:1, 1:3 , and 1:4 gave an increased compressive strength of (9.8 , 9.7 , and 9.3 MPa) compared with the strength of plaster alone (7.9 MPa) . The result reveals that the highest amount of compressive strength was recorded by the samples made in the ratio of stone / plaster equal to 1:1. Thus, the mix made with this ratio of stone to plaster may be the material of choice for filling the upper half of the flask that can withstand stresses created during the packing of methyl methacrylate acrylic resin.

المستخلص:

ان مادة الجبس (plaster) والجبس الحجري (stone) تستعملان بشكل واسع في طب الاسنان وخاصة في اختصاص صناعة الأسنان . حيث توجد حاجة لعمل خليط من الجبس والجبس الحجري لملئ النصف الأعلى من البودقة (flask) أثناء عمل الطقم الكامل . في هذه الدراسة تم قياس قوة الانضغاط لسبع نسب من الجبس الحجري/الجبس المحلي (1:1,1:2,1:3,1:4,2:1,3:1 and 4:1) لقد كانت نسبة الماء المضافة لخلط المواد الجبسية هي ٤٠ ملل / ١٠٠ غم ولجميع النسب، ووفقاً لبيانات التجربة كانت النماذج المتكونة من خليط الجبس الحجري والجبس المحلي في النسب (1:1,1:3 and 1:4) قد اعطت ازدياداً في قوة الانضغاط وبمقدار (9.8 ,9.7,and 9.3) مقارنة بقوة الانضغاط لمادة الجبس المحلي لوحدة (7:9) . لقد اظهرت النتائج بأن اعلى القيم لقوة الانضغاط قد سجلت مع نسبة الجبس الحجري/الجبس المحلي المساوية الى (1:1) ، وعليه فأن خلط الجبس والجبس الحجري بهذه النسبة يعتبر هو الاقوى والافضل لملئ النصف الاعلى من البودقة (flask) اثناء تصنيع الطقم الكامل لتكون مقاومة للضغوط التي تحدث اثناء كبس مادة الاكريلك في البودقة .

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Introduction:

Many researchers agree that the higher the ratio of water to powder, the lower the compressive strength and hardness of the final product will be[1-4] . Combe and Smith[5] reported the effect of adding several salts such as acetate , tartrates , and citrates on the structure of dental plaster and note that , the resultant stone samples have less compressive strength. Tannir and Imam[6] suggeste soaking the powder with water for 1 minute before mixing , to improve the strength and hardness of dental stone.

Combe and Smith[7] recommended the addition of lignosulfonates for improvement in the compressive strength of plaster . Shen et al[8] · proved that by adding K_2So_4 in a proportion of 1% the strength of plaster increased because it creates spheric crystals . Sanad et al[9] also proved that the addition of Arabic gum, calcium oxide (CaO) and calcium hydroxide [$Ca(OH)_2$] doubled the strength of plaster and dental stone . Other researchers believe that the strength of plaster is affected by the following factors : ratio of water to powder , porosity of setting mass, rapidity and length of time of mixing and the addition of retarders or accelerators . And some others note that the addition of material to the mixture of dental plaster and water disturbs the balance of its ingredients[10].

Prombonas and Vlissidis[11] study the most appropriate s/p mixture that may be needed for filling the upper half of the flask . They studied the compressive strength and setting temperature of different proportions of stone to plaster . They conclude that the mix made by the ratio 1:1 had the greater compressive strength and gave the least amount of heat during setting, that save the wax pattern of a denture in a flask from deformation.

Materials & Methods:

Two types of powder were used: Iraqi plaster (AL-Ahliya Co for Gypsum Industries Ltd) and Type III dental stone (GC-new plastone , Dental Industrial Group . 761-1 Hasunuma . Cho, Japan). The following seven ratios of stone to plaster were used: 1:1, 1:2, 1:3, 1:4, 2:1, 3:1, and 4:1. The water/powder ratio was within the limits of the American Dental Association (ADA) specification, which states that a mix of plaster may be made with a range of 40 to 50 ml of water to 100 gm of powder and a mix of stone may be made with a range of 30 to 40 ml of water to 100gm of powder [12]. Mixing 40ml of water with 100mg of powder is common for both plaster and stone, Therefore, the water/powder ratio of 40:100 were selected for all combinations of stone and plaster. Rubber mold was used to produce five cylindrical samples with a height of 40mm and a diameter of 20mm according to (ADA) specification No 25 for gypsum product (1980)[13] . The mix was gently vibrated into the mold and glass slab was placed over the mold to ensure flat and parallel ends. The material was allowed to set for 30 min before separated from the mold. Then the glass slab was taken off the mold and the samples were easily removed from the mold.

A compressive strength testing machine with a 5000kg load was used to measure the compressive strength of the set samples. The compressive strength of stone only and plaster only was also measured to have comparative results (Table 1).

Results :

Compressive strength of both the plaster and stone individually was recorded and the mean values were 7.9 MPa and 15.8 MPa , respectively (Table 1) . The compressive strength of the seven samples of various combinations of stone and plaster are given in (Table 2) .

This table includes the compressive strength for each of the five specimens in each of the seven groups and the mean value for each group . Some values in table 2 depart from the average by more than 15% , so they were discarded and the remaining four values were averaged[13]. The histogram in (Fig.1) gives another view of the compressive strength of each s/p combination.

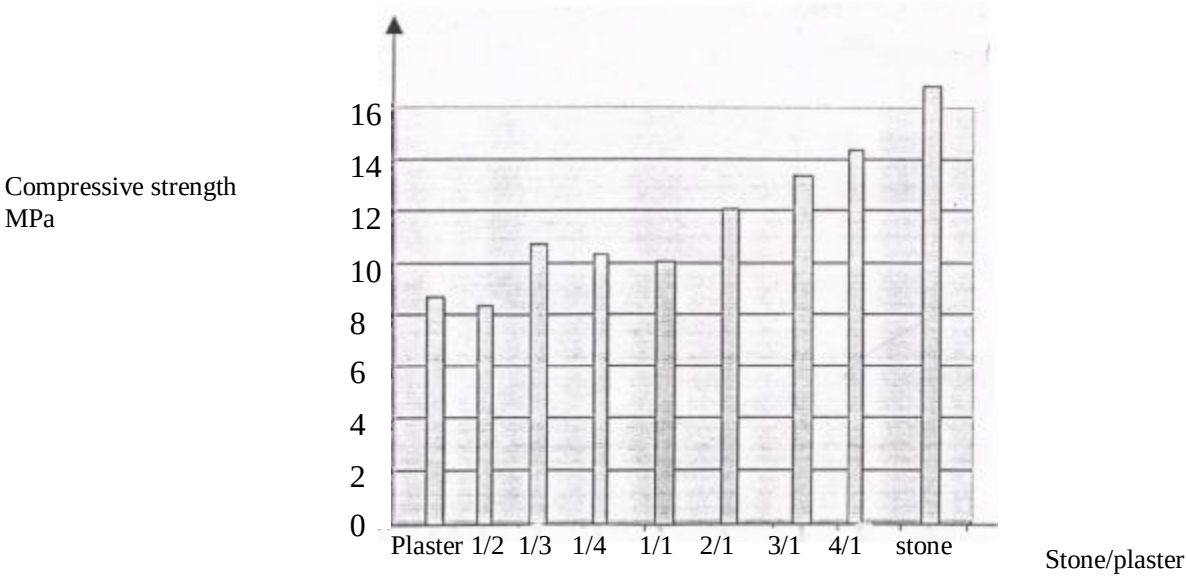
Table 1. Compressive strength of stone and plaster

Sample No.	Compressive strength Of stone	Compressive Of plaster
1	16.3	8.6
2	14.8	7.4
3	15.9	7.6
4	15.1	9.1
5	16.9	6.8
Mean value total	15.8	7.9

Table (2) compressive strength for mixtures with different ratios of stone to plaster (S/P in MP a units)

S/P Samples	1:4	1:3	1:2	1:1	2:1	3:1	4:1
1	9.3	10.1	7.5	8.9	11.6	13.4	12.8
2	10.2	9.7	8.1	10.6	10.8	13.7	13.6
3	9.6	9.6	7.3	8.7	10.4	11.9	14.2
4	8.1	10.2	7.6	9.6	11.9	12.6	12.6
5	*6.0	8.9	6.5	11.2	12.3	*9.4	14.3
Mean value total	9.3	9.7	7.4	9.8	11.4	12.9	13.5

* These values are discarded because they departing from the average by more than 15%.



(Fig.1) Histogram for comparison of compressive strength of all groups of specimens

Discussion :

Stone to plaster ratios of 1:3 , 1:4 , and 1:1 result in an increase in compressive strength over plain plaster , and the compressive strength of s/p ratios of 2:I , 3:1 , and 4:1 have less compressive strength than plain stone (fig 1) . A possible explanation could be that the low

amount of stone in the ratio of s/p 1:3, 1:4, and 1:1 act as an improvement material and the increase in the compressive strength could possibly be caused by the interference of large and small crystals of stone that are dispersed through the larger crystals of plaster . Conversely the addition of small amount of plaster in the stone powder with s/p ratios of 2:1 , 3:1 , and 4:1 decrease the compressive strength , which is possible that the plaster acts as an impurity that disturbs the structure of setting mass and the plaster particles impede the full development and interlacing of stone crystals during setting .

These results agree in certain aspects with the results of microscopic tests that Combe and Smith[5] presented in a previous study, Where they found that all stones, were a mixture of Alfa and Beta hemihydrate in grains of different sizes and shapes. The authors conclude that the differences in size and shape of crystals affect the quantity of water necessary for mixing and consequently, the compressive strength of the set material. The mean value of the sample S/p 1:2 (7.4 MPa) is much smaller than the mean values of the other samples , an explanation may be obtained by microscopic examination of the structure of the S/p ratios.

Conclusion:

Samples of stone to plaster in the ratios of 1:1 , 1:3 , and 1:4 gave an increased compressive strength of (9-8 , 9.7 , 9.3 Mpa) respectively compared with the strength of plaster alone (7.9 Mpa) . Therefore the mix made with the ratio of 1:1 stone to plaster may be the best for filling the upper half of the flask in complete denture construction .

References :

1. Mahler DH., "Hardness and flow properties of gypsum material" *J Prosth Dent*, Vol.1, No.1, pp.188-95, 1951.
2- Jergensen KG.," Investigation on the Hardness and Compressibility of Mode Plaster" *Acta Odontol Scand*, Vol.12, pp.24-38, 1954.
3- Fairhurst CW., "Compressive Properties of Gypsum" *J Dent Res*, Vol.39, pp.812-24, 1960.
4- Graig R., Peyton F., *Restorative Dental Materials*, St louis, Cr Mosby, 1975.
5- Combe Ec., Smith DC., "The Crystal Structure of Gypsum in Relation to its Physical Properties" *J Dent Res*, Vol.43, pp.950-1, 1964.
6- EI Tannir MD., Imam HF., "Effect of Soaking on the Physical Properties of Plaster" *J Dent Res*, Vol.48, pp.423-8, 1969.
7- Combe Ec., smith Dc.," Improved Stones for the Construction of Models and Dies" *J Dent Res* , Vol.50, pp.897-901, 1971 .
8- Shen C., Mohammed H., Kamar A., "Effect of K_2So_4 and $CaSo_4$ Dihydrate Solutions on Crystallization and Strength of Gypsum " *J. Dent Res* , Vol.60, pp.1410-7, 1981.
9- Sanad ME., Combe EC., Crant AA., "The Use of Additives to Improve the Mechanical Properties of Gypsum Products" *J. Dent Res* , Vol.61, pp.808-10, 1982.
10- Phillips Rw. *Science of dental materials*, St Iouis, Cr Mosby 1973.
11-Prombonas A., Vlissidis D., "Compressive strength and Setting Temperature of Mixes with Various Proportions of Plaster to Stone" *J prosth Dent*, Vol.72, pp.95-100, 1994.
12- *American Dental Association* Guide to Dental Materials and Devices. Chicago: ADA, pp104-8, 1974.
13- *American Dental Association Specification* No. 25 for Dental gypsum 1980.