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Properties of Hardened Concrete Produced by Waste Marble Powder

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Abstract

Marble is industrially processed by being cut, polished, and used for decorative purposes, and thus, economically valuable. In marble quarries, stones are cut as blocks through different methods. During the cutting process, 20-30% of a marble block becomes waste marble powder. Marble powder is a waste material generated in considerable amounts in the world. Marble waste leads to a serious environmental problem as well. Therefore, the use of waste marble in the concrete production as an admixture material or aggregate has increasingly become an important issue. In the present study, effect of different usage areas of waste marble on the hardened concrete properties was investigated based on previous studies. In this context, (1) compressive, flexural, and splitting tensile strength, (2) modulus of elasticity, (3) ultrasonic pulse velocity, (4) Schmidt surface hardness, and lastly (5) sorptivity coefficient/porosity of the hardened concrete, were examined. Comparing all results, the proposition "the marble waste can be used in the production of concrete" was discussed in a detailed manner. As a result, the use of waste marble powder in (1) conventional concrete mix, (2) self-compacting concrete mix, and (3) polymer concrete mix, was revealed. Consequently, it was found out that the use of waste marble in the conventional concrete mix as an admixture material or aggregate is suitable as it can improve some properties of the hardened concrete. However, the use of waste marble in the self-compacting and polymer concrete mixes as an admixture material or aggregate is not affected positively in terms of hardened properties of concrete.

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Keywords: Concrete, Hardened Concrete, Recycling, Waste Marble Powder

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1. Introduction

Marble is a metamorphic rock resulting from the transformation of pure lime stone (Malpani, Jegarkal, Shepur, Kiran,& Adi, 2014). The rock is also one of the most important materials used in buildings since ancient times, especially for decorative purposes (Soliman, 2013). Turkey has the 40% of total marble reserve in the world. 7,000,000 tons of marble have been produced in Turkey annually and 75% of these production have been processed in nearly 5000 processing plants. It can be apparently seen that the waste materials of these plants reach millions of tons. Stocking of these waste materials is impossible (Alyamac & Ince, 2009). These type solid waste materials should be inactivated properly without polluting the environment. The most suitable inactivating method nowadays is recycling. Recycling provides with some advantages such as protecting the natural resources, energy saving, contributing to economy, decreasing the waste materials and investing for the future (Kaseva & Gupta, 1999).

Literature review in this study reveals that waste marble uses as raw or admixture material and fine or coarse aggregate in different sectors such as ceramic, brick and building materials. In this study, properties of hardened concrete produced waste marble powder used admixture or fine/coarse aggregate in the concrete were examined in detailed manner. Additionally, it was determined that possibility of usage of these waste in the concrete as admixture material or aggregate affected positively on the hardened properties of concrete. Consequently studies in the literature related hardened properties of concrete produced waste marble were examined.

2. Methodology

In this study, considering the previous studies, properties of hardened concrete produced waste marble investigated in detailed manner. All results are compared suggesting that waste marble could utilize in concrete. As a result of literature, utilization of waste marble in; (1) conventional concrete mix, (2) self-compacting concrete mix, and (3) polymer concrete mix, was revealed. Waste marble powder was used as binder in cement or as fine/coarse aggregate in sand in producing conventional concrete mix. However, the waste was utilized generally as fine aggregate in sand in self-compacting concrete mix. Waste marble was used also as aggregate with different sieve aperture in polymer concrete mix. Experiments were carried out for hardened concrete in literature were compressive, flexural, splitting, modulus of elasticity, ultrasonic pulse velocity, Schmidt surface hardness, and lastly sorptivity coefficient/porosity tests. All results were analyzed for each study in detailed manner and these results were tabulated in two parts.

3. Results

3.1. Compressive- Flexural- Splitting Strength and Modulus of Elasticity

Compressive, flexural, splitting strength and modulus of elasticity results were summarized in Table 1. Most suitable replacement ratio of waste marble for the studies that waste marble was replaced as binder in cement in conventional concrete mix was determined as 5-10%. This ratio was improved physical and mechanical properties of conventional concrete. The reasons for improved properties of hardened concrete were explained as follows:

- The compressive strength may be due to that the active SiO_2 in waste marble powder can react with the $Ca\,(OH)_2$ in concrete to form secondary calcium silicate hydrate and make it chemically stable and structurally dense (Omar, Abd Elhameed, Sherif,& Mohamadien, 2012).
- The usage of waste marble powder in concrete show as a filler effect. The reason can be said as that the filler is an inert addition and it can be assumed as ultrafine aggregates filling voids in concrete. The usage of waste marble powder reduces the porosity in concrete matrix physically, and has an important binding property which is developed by hydration of calcite and C_3A chemically (Ergun, 2011).

Table 1. Comparison Some Results Of Compressive, Flexural, Splitting Strength And Modulus Of Elasticity.

	Mixing Ratio Of Concrete						
Type Of Concrete	Using Of Waste Marble In The Concrete	Waste Marble Ratio	Other Constituents Ratio	Cure Conditions	Comparing Criteria	Result	Ref.
Conventional Concrete	As Fine Aggregate In Sand	(20-33-50)%	%(20-33-50) Quarry Stone And Sand	7 And 28 Days	Concrete Mix Produced By Sand As Fine Aggregate Without Waste Marble	It Is Observed That Mix Containing 40% Sand, 40% Marble Sludge Powder, 20% Quarry Rock Dust Had The Best Compressive Strength And Mix Containing 50% Quarry Rock Dust, 50% Marble Sludge Powder And 20% Sand ,40% Quarry Rock Dust, 40% Marble Sludge Powder Had The Best Values For Split Tensile Strength Of Concrete.	Malpani, Jegarkal, Shepur, Kiran,& Adi, 2014.
Conventional Concrete	As Fine Aggregate In Sand	50%	%50 Quarry Stone And Sand	3,7 And 28 Days	Concrete Mix Produced By Sand As Fine Aggregate Without Waste Marble	The 7 Days And 28 Days Compressive Strength Of Green Concrete Was 6.49% And 9.49% Higher Than Controlled Concrete Respectively. Similarly The 7 Days And 28 Days Split Tensile Strength Of Green Concrete Was 14.62 And 8.66% Which Were Higher Than Controlled Concrete Respectively.	Hameed & Sakar, 2009.
Conventional Concrete	As Fine Aggregate In Sand	(5-10-15-20)%	Sand	7,14 And 28 Days	Concrete Mix Produced By Sand As Fine Aggregate Without Waste Marble	By Increasing The Waste Marble Granules The Compressive Strength Values Of Concrete Tended To Increase At Each Curing Age. Furthermore, The Mean Strength Of Concrete Mixes With Marble Granules Was 5-10% Higher Than The Reference Concretes. The Flexural Strength Of Waste Marble Mix Concrete Increased With The Increase Of The Waste Marble Ratio.	Baboo, Khan, Abhishek, Tabin,& Duggal, 2011.
Conventional Concrete	As Fine Aggregate In Sand	(5-7.5-10-15)%	Sand (Two Different Water/Cement (W/C) Ratio (0.40-0.50)	7,28 And 56 Days	Concrete Mix Produced By Sand As Fine Aggregate Without Waste Marble	The Concrete Compressive Strength Increased With The Increase Of Marble Dust Ratio As Sand Replacement Up To 15.0% Of Sand By Weight. Also, The Use Of Marble Dust As Sand Replacement Was More Effective With Lower W/C Ratio. Generally, The 10.0% Marble Dust Content As Sand Replacement Was Considered The Optimum Content That Achieving The Highest Concrete Tensile Strength. This Trend Was The Same For 0.50 And 0.40 W/C Ratio.	Aliabdo, Abd Elmoaty,& Auda, 2014.
Conventional Concrete	As Fine Aggregate In Sand	(5-10-15)%	Sand	7,28,90 And 360 Days	Concrete Mix Produced By Sand As Fine Aggregate Without Waste Marble	All Specimens Produced By Waste Marble Dust Had Higher Compressive Strength Values Than Control Specimens. Furthermore, Compressive Strength Increased With Increased Curing Age And Marble Waste Ratio.	Binici, Kaplan,& Yilmaz, 2007.

		Mixing Ratio Of Concrete					
Type Of Concrete	Using Of Waste Marble In The Concrete	Waste Marble Ratio	Other Constituents Ratio	Cure Conditions	Comparing Criteria	Result	Ref.
Conventional Concrete	As Coarse Aggregate	100%		7 And 28 Days	Concrete Produced By Crushed Stone Aggregate As Coarse Aggregate (It Was Targeted That C 25-30 Concrete Class According To Ts 802 Standards)	Targeted Compressive Strength Values Of Concrete Produced Waste Marble Aggregate Were Achieved According To Ts Standards. But, Compressive Strength Of Concretes Produced Crushed Stone Aggregate Which Was Higher Than Concrete Produced Waste Marble Aggregate At All Curing Ages.	Ceylan & Manca, 2013.
Conventional Concrete	As Coarse Aggregate	100%	Granulated Blast Furnace Slag (Gbfs) And River Sand (As Fine Aggregates In This Study)	1,7, 28 And 90 Days	Concrete Produced By Crushed Lime Stone As Coarse Aggregate.	The Use Of Marble And Gbfs Resulted In A Significant Increase In The Compressive Strength Of The Concrete. Upon Aging The Compressive Strength Values Of All Concrete Types Increased. The Use Of Marble And Granite In Concrete Improves The Flexural- And Splitting-Tensile Strength Of Concrete. The Splitting-Tensile Strengths Of Marble And Granite Concretes Were Higher Than That Of The Conventional Concrete. The Average Values Of The Modulus Of Elasticity Of Marble And Granite Concretes Were 79% Higher Than Those Of The Conventional Concrete.	Binici, Shahb, Aksogan,& Kaplan, 2008.
Conventional Concrete	As Coarse Aggregate	(20-50 And 100)%	Primary Aggregates (Pa; Basalt, Granite And Limestone)	28 Days	Concrete Produced By Primary Aggregates (Pa) As Coarse Aggregate.	There Was A Slight Loss Of Compressive Strength At 28 Days With An Increase In The Replacement Ratio Of Pa With Marble Aggregate. Although Results Indicated A General Downward Trend Of The Mean Compressive Strength At 28 Days With Increasing Incorporation Ratio, This Decrease May Be Considered Almost Insignificant With Variations Up To 10.3% (For The Granite Concrete Mix).	Andre, Brito, Rosa,& Pedro, 2014.
Conventional Concrete	As Binder In Cement	(2,5-5-7,5-10-12,5-15-17,5-20)%	Ordinary Portland Cement (Opc)	7,28 And 56 Days	Concrete Mix Produced By Cement As Binder Without Waste Marble	Increasing The Marble Powder Ratio Replacement Of Cement Led To The Increasing As The Compressive Strength By About (25% And 8%) For The Marble Powder Replacement Ratios (5% And 7.5%) Compared To The Control Mix. Increasing Indirect Tensile Strength And Modulus Of Elasticity Was Recast Of The By Using Marble Powder Ratios (5% And 7.5%) Compared To The Control Mix.	Soliman, 2013.

		Mixing Ratio Of Concrete					
Type Of Concrete	Using Of Waste Marble In The Concrete	Waste Marble Ratio	Other Constituents Ratio	Cure Conditions	Comparing Criteria	Result	Ref.
Conventional Concrete	As Binder In Cement	(5-7.5-10)%	Diatomit And Opc	7,28 And 90 Days	Concrete Mix Produced By Cement As Binder Without Waste Marble	The Concrete Containing 5% Waste Marble Powder As Partial Replacement By Weight For Cement With A Super Plasticizing Admixture Had Higher Compressive Strength Than That Of The Control Concrete Specimens. Consequently, The Replacement Of Cement With Diatomite And Waste Marble Powder Separately Or Together Could Be Used To Improve The Mechanical Properties Of The Conventional Concrete Mixtures.	Ergun, 2011.
Conventional Concrete	As Binder In Cement	(5-7.5-10-15)%	Opc (Two Different Water/Cement (W/C) Ratio (0.40-0.50)	7,28 And 56 Days	Concrete Mix Produced By Cement As Binder Without Waste Marble	The Compressive Strength Of Cement Mortar Increases By The Use Of Marble Dust As Cement Replacement. A Reduction In The Compressive Strength Of Marble Dust Modified Mortar Of 5.0% Lower Than Control Specimen Is Reported At 15.0% Marble Dust As Cement Replacement. A Significant Improvement In Concrete Tensile Strength Is Recorded Due To The Use Of Marble Dust As Cement Replacement.	Aliabdo, Abd Elmoaty,& Auda, 2014.
Conventional Concrete	As Binder In Cement	(5-10-15-20)%	Opc	14 And 28 Days	Concrete Mix Produced By Cement As Binder Without Waste Marble	Test Results Indicate That The 10% Of Marble Dust In The Cement Concrete Given The Best Compressive And Tensile Strength. And Also Increase In Curing Days Increased The Strength Of Marble Dust Concrete When Compared From 14 Days To 28 Days.	Vaidevi, 2013.
Conventional Concrete	As Binder In Cement	(5-10-15-20)%	%(25-50-75) Waste Lime And Opc	7,28 And 90 Days	Concrete Mix Produced By Cement As Binder Without Waste Marble	Compressive Strength Of The Concrete Has Increased With Increasing Percentages Of M.P Additions At All Curing Ages. The Highest Compressive Strength Appears When The Highest Proportion Of M.P Specimen, Especially At Early Curing Ages. Using 50% Lsw With 15% M.P Increased The Splitting Tensile Strength Compared With Normal Concrete Mix. Modulus Of Elasticity Of Green Concrete That The Modulus Of Elasticity Increased For With Increasing The Limestone Waste With Mp In Cement Content.	Omar, Abdelhameed, Sherif,& Mohamadien, 2012.
Self-Compacting Concrete	As Binder In Cement	(30-42-50)%	Opc	28 Days	All Specimens Were Compared With Together.	It Can Be Seen That, At 28-Day Age, The Compressive Strength Decreases With An Increase In Mp Content.	Tayeb, Abdelbaki,Madani,& Mohamed, 2011

	Mixing Ratio Of Concrete						
Type Of Concrete	Using Of Waste Marble In The Concrete	Waste Marble Ratio	Other Constituents Ratio	Cure Conditions	Comparing Criteria	Result	Ref.
Self-Compacting Concrete	As Binder In Cement	(10-20-30)%	Lime Stone Powder, Basalt Powder, Opc	7,28,90 And 400 Days	Concrete Mix Produced By Cement As Binder Without Waste Marble	All The Mineral Admixtures Have Shown Significant Performance Differences And The Highest Compressive Strength Obtained For Addition Of 20 % The Marble Powder Mixture. When The Strength Of Scc Mixtures Increased, Static And Dynamic Elastic Moduli Also Increased And The Highest Static Elastic Modulus And Dynamic Elastic Modulus Obtained For Addition Of 20 % And 10 % Marble Powder, Respectively.	Uysal,& Yilmaz, 2011.
Self-Compacting Concrete	As Binder In Cement	In Concrete Of 1 M^3, (50-100-150-200-250-300) Kg	Fly Ash And Opc	28 Days	Concrete Mix Produced By Cement As Binder Without Waste Marble	The Compressive And Flexural Strengths Decreased Because Of Increase In Marble Powder Content. But, Differences Of Compressive Strengths Between Control Specimen And Specimens Containing Marble Powders (Especially, 50-100-150-200 Kg/M^3 Of Marble) Were Not Too Much. Therefore, The Maximum And The Optimum Usage Amount Of Marble Powder Can Be Said As 200 Kg/M^3 Content In Order To Obtain Best Performance For Both Of Fresh And Hardened Properties Of Scc.	Topcu, Bilir,& Uygunoglu 2009.
Self-Compacting Concrete	As Binder In Cement	100%	Opc	3,7,28 And 56 Days	Concrete Mix Produced Cement As Binder Without Waste Marble	10% Replacement Of Cement With Marble Powder Caused About 10–20% Compressive Strength Decrease In Late Age. But, An Even More Positive Effect Of Marble Powder Was Evident At Early Ages, Due To Its Filler Ability.	Corinaldesi, Moriconi,& Naik, 2010.
Self-Compacting Concrete	As Binder In Cement	(5-10-15-30)%	Naturel Puzolan And Opc	7,28,56 And 90 Days	Concrete Mix Produced Cement As Binder Without Waste Marble	The Use Of Marble Powder Content (5–30%) Enhances The Rheological Properties Of Both Mortar And Concrete. However, A Reduction Of Compressive Strength Was Observed With Naturel Puzolan And Marble Powder Addition Compared To Control Concrete.	Belaidi, Azzouz, Kadri,& Kenai, 2012.
Self-Compacting Concrete	As Binder In Cement	(5-10-20)%	Lime Stone (Lf), Fly Ash (Fa) And Opc	28 And 90 Days	Concrete Mix Produced By Cement As Binder Without Waste Marble	Considering The Binary Mixtures (Opc + Marble) It Was Observed That There Was A Systematic Reduction In Compressive Strength Of Concretes As Marble Was Used. A Similar Trend Was Observed For Ternary System Mixtures (Opc+ Fa+ Marble). Like Compressive Strength, Splitting Tensile Strengths Of The Ternary Mixtures Were Generally Higher Than Those Of	Geseoglu, Guneyisi, Kocabag, Bayram,& Mermerdas, 2012.

		Mixing Ratio Of Concrete					
Type Of Concrete	Using Of Waste Marble In The Concrete	Waste Marble Ratio	Other Constituents Ratio	Cure Conditions	Comparing Criteria	Result	Ref.
						Binary Mixtures.	
Self-Compacting Concrete	As Fine Aggregate In Sand	10%	Sand	3,7,28 And 56 Days	Concrete Mix Produced By Sand As Fine Aggregate Without Waste Marble	10% Replacement Of Sand With Marble Aggregate Caused About 10–20% Compressive Strength Decrease In Late Age.	Corinaldesi, Moriconi,& Naik, 2010.
Polymer Concrete	As Aggregate With Different Sieve Aperture		Polyester Was Used As Filler Material		Waste Marble Aggregates Having Different Sieve Aperture Were Compared With Together.	When Sieve Apertures Were Higher, Compressive And Flexural Strength Of Concretes Were Decreased.	Soykan & Ozel, 2012.

Table 2. Obtained Results Of Schmidt Surface Hardness, Ultrasonic Pulse Velocity And Porosity/Sorptivity Coefficients.

	For Waste Marble			Results			
Type Of Concrete	Using Location	Ratio	Comparing Criterion	Ultrasonic Pulse Velocity (Upv)	Schmidt Surface Hardness	Porosity / Sorptivity Coefficient	Ref.
Conventional Concrete	As Binder In Cement / As Fine Aggregate In Sand	(5,7.5,10, 15 (Two Different Water/Cement (W/C) Ratio (0.40-0.50))%	Concrete Mix Produced By Cement As Binder Without Waste Marble / Concrete Mix Produced By Sand As Fine Aggregate Without Waste Marble	The Use Of Marble Dust Either As A Cement Replacement Or A Sand Replacement Has Insignificant Effect On The Value Of The Ultrasonic Pulse Velocity.		When Usage Of Marble Dust As A Partial Replacement Of Sand Showed An Improvement In Porosity Values, Usage Of Marble Dust As A Partial Replacement Of Cement Decreased The Porosity.	Aliabdo, Abd Elmoaty,& Auda, 2014.
Conventional Concrete	As Coarse Aggregate	100%	Concrete Produced By Crushed Stone Aggregate As Coarse Aggregate (C 25-30 Concrete Class Properties Were Targeted According To Ts 802 Standards.)	While Upv Value Was 4.54 Km/S For Concrete Produced As Waste Marble Aggregate, This Value Were 4.48 Km/S For Concrete Produced Crushed Stone Aggregate. The Obtained Results For Two Different Situations Were Suitable According To Standards Of C	While Schmidt Surface Hardness Value Was 25 For Concrete Produced As Waste Marble Aggregate, This Value Was 23 For Concrete Produced Crushed Stone Aggregate. The Obtained Results For Two Different Situations Were Suitable According To Standards Of C 25/30 Concrete Class.		Ceylan & Manca, 2013.

For Waste Marble				Results			
Type Of Concrete	Using Location	Ratio	Comparing Criterion	Ultrasonic Pulse Velocity (Upv)	Schmidt Surface Hardness	Porosity / Sorptivity Coefficient	Ref.
				25/30 Concrete Class.			
Self-Compacting Concrete	As Binder In Cement	(10-20-30)%	Concrete Mix Produced By Cement As Binder Without Waste Marble	Upv Values Changed Between 4.2 Km/S And 4.9 Km/S For Different Ratios Of Marble Waste. Upv Values Of Specimens Decreased With Increasing Marble Waste Ratios In The Mixes.			Uysal, & Yilmaz, 2011.
Self-Compacting Concrete	As Binder In Cement	In Concrete Of 1 M^3, (50-100-150-200-250-300) Kg	Concrete Mix Produced By Cement As Binder Without Waste Marble	Upv Values Changed Between 4.2 Km/S And 4.6 Km/S For Different Ratios Of Marble Waste.		The Capillarity Coefficient Of Concrete Decreased With The Increase In Filler Material Content Between 50 And 200 Kg/M^3.	Topcu, Bilir,& Uyguno glu 2009.
Self-Compacting Concrete	As Binder In Cement	(5-10-20)% Lime Stone (Lf), Fly Ash (Fa) And Opc Were Used As Other Constituents.	Concrete Mix Produced By Cement As Binder Without Waste Marble			All Of The Sorptivity Coefficient Values Of Concretes Incorporated Marble Or Lf, And Fa Were Considerably Less Than That Of The Control Mix. The Filling Effect Of Marble Was Clearly Observed When The Change In Replacement Levels Of Fillers Versus Sorptivity Coefficients Examined.	Corinaldesi, Moriconi,& Naik, 2010.
Polymer Concrete	As Aggregate With Different Sieve Aperture		Waste Marble Aggregates Having Different Sieve Aperture Were Compared With Together.	All Of Results, Values Of Ultrasonic Pulse Velocity Were Determined As Zero.	The Trend (Decreasing Or Increasing) Was Not Confirmed According To Sieve Aperture. Different Results Were Determined For Different Sieve Aperture.		Soykan & Ozel, 2012.

3.2. Ultrasonic Pulse Velocity, Schmidt Surface Hardness, and Sorptivity Coefficient/Porosity

Schmidt surface hardness test, ultrasonic pulse velocity test and determination of porosity/sorptivity coefficients were other carried test on the hardened concrete mixes which were summarized in Table 2. In previous studies about conventional concrete mixes produced by waste marble which was used as binder in cement and as fine/coarse aggregate in concrete.

In the study, which is based on replacement of cement or sand with waste marble powder, (Aliabdo, Abd Elmoaty,& Auda, 2014) determination of ultrasonic pulse velocity of conventional concrete was carried out. The use of marble dust either as a cement replacement or a sand replacement has insignificant effect on the value of the ultrasonic pulse velocity. Porosity of concrete also decreases with the increase of marble dust addition which act as cement revealing comparable results to control specimens in case of 0.50 and 0.40 w/p ratios. In addition, the usage of marble dust as a partial replacement of sand showed an improvement in porosity values. This improvement in porosity could be explained as a result to the filler effect of marble dust.

In some studies, waste marble was used as coarse aggregate in conventional concrete mixes. In one of these studies, ultrasonic pulse velocity and Schmidt surface hardness values were determined and C 25-30 concrete class properties was targeted according to TS 802 Standards. Results obtained in the previous study (Ceylan & Manca, 2013) for ultrasonic pulse velocity and Schmidt surface hardness tests were suitable according to TS standards.

Waste marble was also used as replaced binder in self-compacting concrete mixes. Ultrasonic pulse velocity and Sorptivity Coefficient/Porosity values were obtained in these studies. Ultrasonic pulse velocity values were determined between 4, 2 and 4, 9 km/s. While sorptivity coefficient was changed by porosity as inverse proportionality, it was changed by compressive strength as directly proportional (Topcu, Bilir,& Uygunoglu, 2009). In other study, sorptivity coefficient was decreased with increasing waste marble replacement ratio in cement (Geseoglu, Guneyisi, Kocabag, Bayram,& Mermerdas, 2012).

Lastly, waste marble had different sieve apertures were used as aggregate in polymer concrete mixes. The trend (decreasing or increasing) was not confirmed according to sieve aperture for results of ultrasonic pulse velocity and Schmidt surface hardness tests. Different results were determined for different sieve aperture. Consequently, it was concluded that grain size diameter of minerals were affected on polymer concrete technology, but, correlation coefficient between mechanical properties and grain size diameter was not high (Soykan & Ozel, 2012).

4. Conclusion

Considering the all of the results in this study, using of waste marble in the conventional concrete as binder or fine/coarse aggregate was positively affected on properties of hardened concrete. Whereas in self-compacting concrete, increasing of waste marble replacement ratios in the concrete were decreased the mechanical properties of concrete. Same declining trend of hardened properties of concrete was also determined in the polymer concrete.

Consequently, it was concluded that replacement of waste marble with cement or aggregate in conventional concrete was improved properties of hardened concrete. But, using of waste marble in self-compacting or polymer concrete was not affected positively on the properties of hardened concrete.

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