

Bibliographical summary of researches carried out on the recycling and recovery of waste from mining for high-performance concrete production

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Abstract

The exhaustion of natural deposits of aggregates and the difficulties in opening new quarries requires the search for new sources of supply. For this, the recycling and recovery of waste is today considered a solution in order to meet the deficit in terms of production on the one hand and environmental protection

The overall objective of this paper is to reviews studies on the use of natural waste as an additional material in the further development of various recycled concretes., Such as marble powder (MP), metakaolin (MK), to discuss the effects of each waste on compressive strength, sorptivity, permeability, water absorption, chloride penetration, corrosion resistance, then assess which of these wastes is a better replacement for cement in concrete.

Keywords: waste, mine and quarry, environment, recycling, Concrete, physical and mechanical characteristic

1. Introduction

Due to the large production of cement that causes significant energy consumption and carbon dioxide (CO₂) emissions, This has become a major concern for sustainable development and environmental regulation. In an attempt to solve this environmental problem researchers were challenged to reduce Cement production by replacing a proportion of the cement with waste materials that potentially improve the specifications of fresh and hardened concrete. In this work we attempted to review the results obtained so far about using MP and MK as a partial replacement of cement. Moreover, the effect on the selected physical and mechanical properties was evaluated [2].

a. Marble Powder

Marble powder is an inert material produced during the extraction and processing of very pure limestone rock "CaCO₃", so it is a calcite, which is one of the most common minerals together with dolomite. [1]
Recently, the study of waste management is increasing worldwide, especially marble waste. Due to the increase in production in marble factories, the large volume of waste could not be stored [5]

b. Metakaolins

Metakaolins are obtained by calcination of kaolin clay (hydrated alumina silicate) in the range of 600-900°C. The calcination temperature depends on the level of purity of the kaolin used
During this process, metakaolin is formed and gaseous water molecules are emitted in accordance with the following reaction :



2. Physical and Chemical Properties:

2.1. Physical Properties:

Table I and II shows an example of an overview of the physical properties of MP and MK cited by some authors. Almost all authors reported Close values. The reason behind this attribute is the change in the location of the source.

Propeties	Deepanker kumar Ashiche 2018	Marpeet Singh 2019	Aboubakr boukhelkhal 2012	R.Chaid 2011
Blaine (m2/kg)	332	250	360	350
Specific gravity	2.21	2.7	2.87	2.72
Loss on ignition (%)	36.87	40	42.78	43.3

Table I: Physical properties of MP used in several research projects

Propeties	V.Nezrka 2019	Vavdeep Singh 2019	Gholmareza 2019	Rakesh 2018
Blaine (m2/kg)	15	14	14.5	15
Specific gravity	2.65	2.52	2.6	2.5
Loss on ignition (%)	≤1	1.09	0.68	1.85

Table II : Physical properties of MK used in several research projects

2.2. Chemical properties:

Table III shown the review on chemical properties of MP. Majority of authors reported higher amount of CaO, while Table V shown the review on chemical properties of MK. Majority of authors reported higher amount of SiO₂ presence Al₂O₃ accomplish as second major element in MK. These leads to occurrence of pozzolanic reaction while hydration process.

Researchers	So ₃ %	MgO%	CaO%	Fe ₂ O ₃ %	Al ₂ O ₃ %	SiO ₃ %
Deepanker kumar Ashiche 2018	0.33	14,36	61.83	0.65	0,67	8.38
Marpeet Singh 2019	3,17	2.46	60.41	0.78	4.62	3.83
Adity Rana 2015	-	-	42.13	2.98	2.2	44.1
Aboubakr boukhelkhal 2012	o.o1	0.12	56.02	0.06	0.13	0.42
R.Chaid 2011	0.184	2.55	39.43	0,174	0.38	1.245

Table III : Researchers providing the chemical characteristics of the MP used in their studies

Researchers	So3%	MgO%	CaO%	Fe2O3%	Al2O3%	SiO2%
V.Nezrka 2019	-	-	-	1.1	40.1	54.1
Vavdeep Singh 2019	-	-	0.39	4.32	41	52.1
Rakesh 2018	0.03	0.2	1.15	1.21	35.14	58.1
Ahmed Tafraoui 2014	-	1.23	0.03	1.38	41.5	53.56
Gholmareza 2019	30.4	-	3.32	0,85	17.6	74.2

Table V : Researchers providing the chemical characteristics of the MK used in their studies

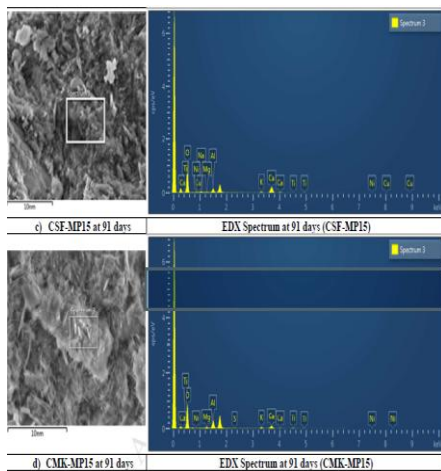


Fig.1: MK

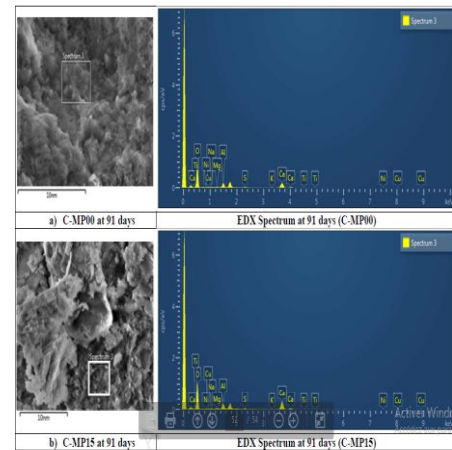
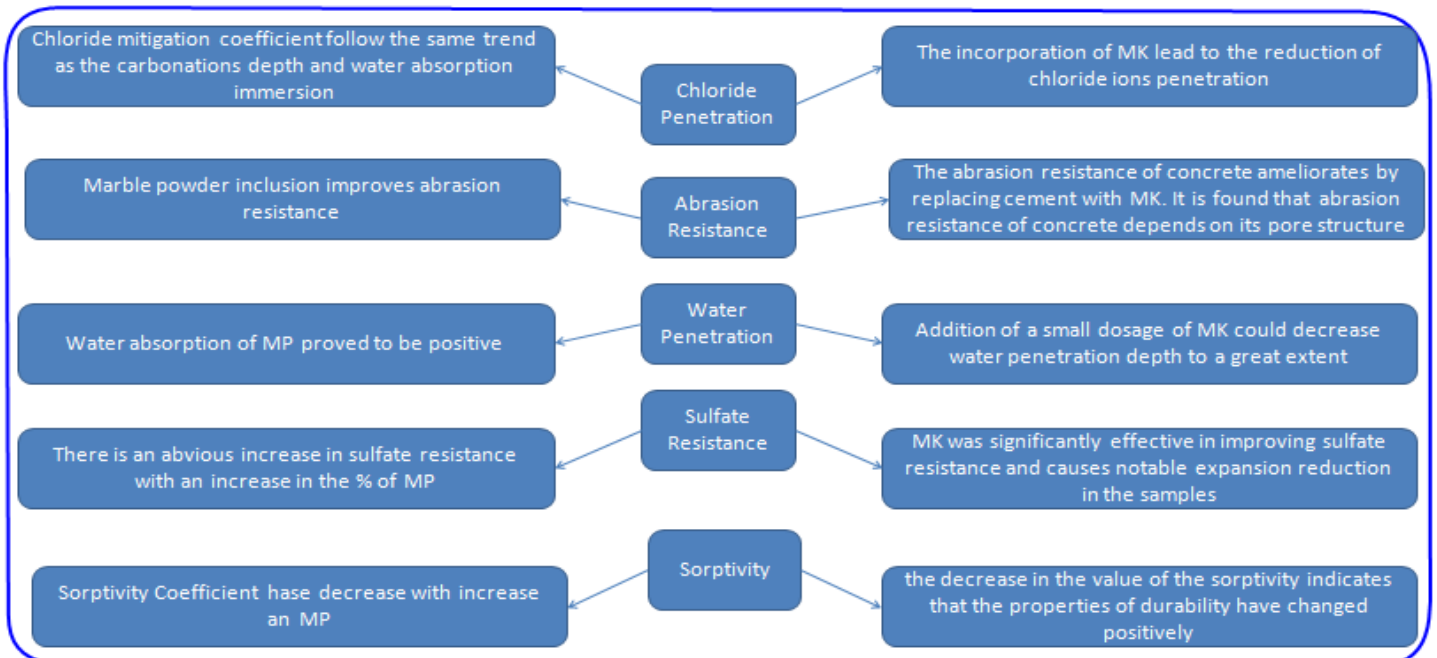


Fig 2: MP

Fig.1let Fig2. Represente EDX analysis of concrete with and without (MK,MP) after 91Days

3. Results and Discussion

Plenty investigations were conducted by several authors with marble powder and metakaolin as supplementary material in concrete. The following results was reported from authors :



4. Conclusion

To improve the economic recovery of wastes, concrete researchers have proposed substituting a proportion of concrete with wastes. When substituted at appropriate ratios, MP and MK exert no adverse effects on concrete quality but may enhance the mechanical specifications. According to the reviewed studies, the use of this wastes in concrete production benefits the economy and reduces environmental pollution.

References

1. Ashish DK, Concrete made with waste marble powder and supplementary cementitious material for sustainable development, *Journal of Cleaner Production* (2018),
2. Şahan Arel H, Recyclability of Waste Marble in Concrete Production, *Journal of Cleaner Production* (2016)
3. Manpreet Singh, Kailash Chaudhary, Anshuman Srivastava, Kuldip Singh Sangwan and Dipendu Bhunia, A study on environmental and economic impacts of using waste marble powder in concrete, *Journal of Building Engineering*
4. C1679-14: Measuring Hydration Kinetics of Hydraulic Cementitious Mixtures Using Isothermal Calorimetry, 2014,
5. Boukhelkhal, A., Azzouz, L., Belaïdi, A. S. E., & Benabed, B. (2016) 'Effects of marble powder as a partial replacement of cement on some engineering properties of self-compacting concrete', *Journal of Adhesion Science and Technology*, 30(22), 2405-2419.
6. V. Nežerka, P. Bílý, V. Hrbek, J. Fládr, Impact of silica fume, fly ash, and metakaolin on the thickness and strength of the ITZ in concrete, *Cement and Concrete Composites*(2019), doi: <https://doi.org/10.1016/j.cemconcomp.2019.05.012>.
7. Ahmed Tafaoui, Durability of the Ultra High Performance Concrete containing metakaolin, 2016
8. G. Asadollahfardi, P. MohsenZadeh, S.F. Saghravani, N. mohamadzadeh, The effects of using metakaolin and micro-nanobubble water on concrete properties, *Journal of Building Engineering* (2019), doi: <https://doi.org/10.1016/j.job.2019.100781>
9. Ayobami Busari, Sustainable concrete for rigid pavement construction using de-hydroxylated Kaolinitic clay: Mechanical and microstructural properties <https://doi.org/10.1016/j.conbuildmat.2019.03.170>
10. Yunyao Wang, Zhonghe Shui, Xu Gao, Yun Huang, Rui Yu, Xiaosheng Li, Rui Yang, Utilizing coral waste and metakaolin to produce eco-friendly marine mortar: hydration, mechanical properties and durability,