2 JURNAL SYARAT KHUSUS

DAN

11 JURNAL TAMBAHAN

JEJAK KOMUNIKASI SAMPAI DENGAN PENERBITAN ARTIKEL

Development and assessment of cement and concrete made of the burning of quinary by-product.

Journal of Materials Research and Technology

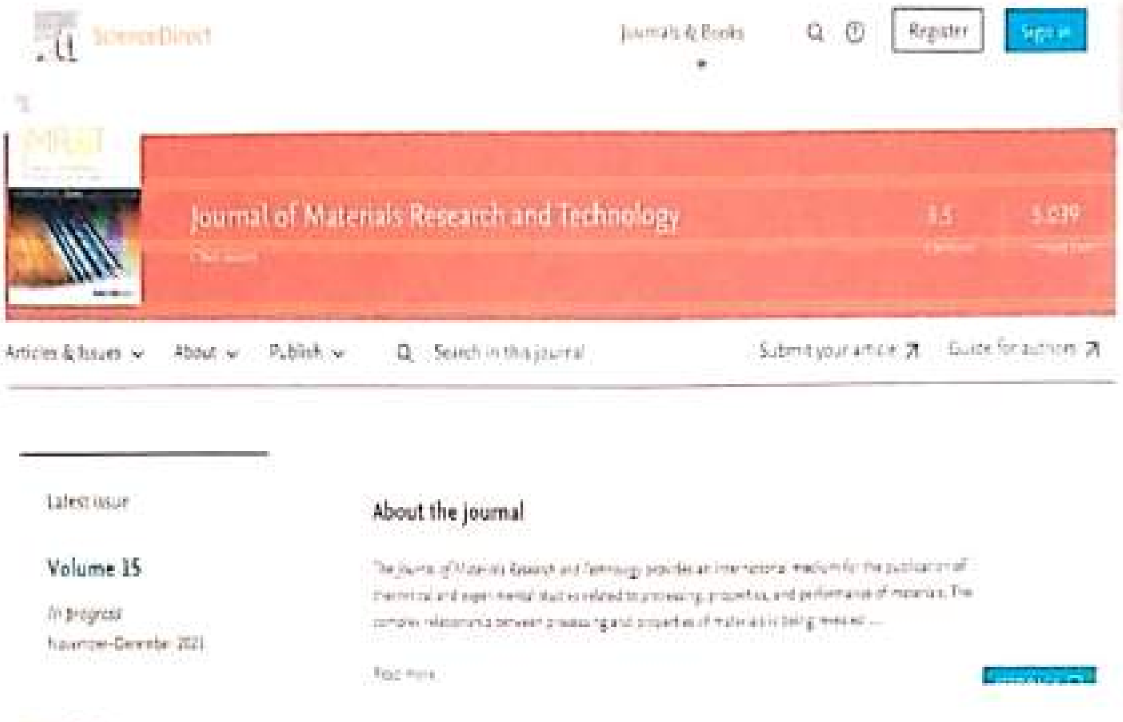
ISSN : 2238-7854

SEBAGAI PENULIS PERTAMA

(Publish – 2021)

TERINDEX

SCOPUS - Q 1



Judul Artikel : Development and assessment of cement and concrete made of the burning of quinary by-product.

Doi Number : https://doi.org/10.1016/j.jmrt.2021.09.140

Name Journal : Journal of Materials Research and Technology

ISSN : 2238-7854

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Universities and research institutions in Brazil

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- Ceramics and Composites
- Metals and Alloys
- Surfaces, Coatings and Films

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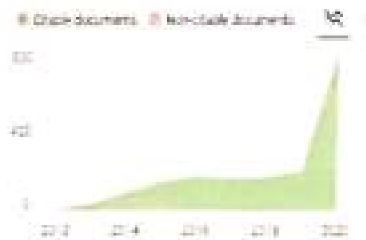

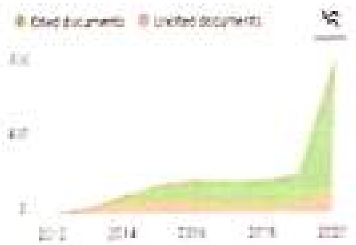

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Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 11 Juli 2021 01.18
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

My Dear Brother,

Assalamualaikum.

There is a review result of new cement article in the email attachment. Please let me know answer that I wanted previous email.

Sincerely,
Serkan

[Kutipan teks disembunyikan]

Review Results of Syarif.docx
16K

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 11 Juli 2021 01.24
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: muhsyarif00@gmail.com

Thank you very much. I hope so.
With my best regards,
Serkan

Sent from Yahoo Mail on Android

On Sun, Jul 11, 2021 at 11:18 AM, Muhammad Syarif
<muhsyarif00@gmail.com> wrote:
[Kutipan teks disembunyikan]

Muhammad Syarif <muhsyarif00@gmail.com> 11 Juli 2021 01.38
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

waalaikumsalam Wr..Wb

Ok, my brother is studying and I will add material for the introduction according to the reference from the reviewer

[Kutipan teks disembunyikan]

Muhammad Syarif <muhsyarif00@gmail.com> 11 Juli 2021 02.03
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

My Brother please send me the submet script on JMR&T.

[Kutipan teks disembunyikan]

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 11 Juli 2021 02.28
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: muhsyarif00@gmail.com

My Dear Brother,
What does the submet script means?
Sincerely,
Serkan

Sent from Yahoo Mail on Android

On Sun, Jul 11, 2021 at 12:03 PM, Muhammad Syarif
<muhsyarif00@gmail.com> wrote
[Kutipan teks disembunyikan]

Muhammad Syarif <muhsyarif00@gmail.com> 11 Juli 2021 02.34
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

Gmail

Muhammad Syarif <muhsyarif00@gmail.com>

Fw: ENC: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643

2 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 11 Juli 2021 02.33
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

De: em.jmrt.0.742eae.398b9622@editorialmanager.com [em.jmrt.0.742eae.398b9622@editorialmanager.com] em nome de Journal of Materials Research and Technology [em@editorialmanager.com]
Enviado: quinta-feira, 24 de junho de 2021 3:01
Para: Andre Gustavo de Sousa Galdino
Assunto: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643

Manuscript Number: JMRT-D-21-01643

Physical, chemical properties, and XRD analysis of new clinker and cement made of the burning of quinary by-product

Dear Dr. Galdino,

Thank you for submitting your manuscript to Journal of Materials Research and Technology.

I have completed my evaluation of your manuscript. The reviewers recommend reconsideration of your manuscript following major revision. In fact, one of the reviewers (#2) advised against publishing your manuscript and raised relevant criticisms that I hope you can answer suitably to allow further consideration of your manuscript.

I invite you to resubmit your manuscript after addressing the comments below. Please resubmit your revised manuscript by Jul 14, 2021.

When revising your manuscript, please consider all issues mentioned in the reviewers' comments carefully: please outline every change made in response to their comments and provide suitable rebuttals for any comments not addressed. Please note that your revised submission may need to be re-reviewed.

To submit your revised manuscript, please log in as an author at https://www.editorialmanager.com/jmrt/, and navigate to the "Submissions Needing Revision" folder.

Journal of Materials Research and Technology values your contribution and I look forward to receiving your revised manuscript.

Kind regards,

Prof. Sergio Neves Monteiro, PhD
Coeditor

Journal of Materials Research and Technology

Reviewers comments:

Reviewer #1: The objective of the article is to evaluate potential in the burning of waste materials such as household waste, the coal ash waste, Mediterranean soils and calcined clay that are currently not contributing very much in the living conditions of people. The aim is to assess potential manufacture of new form of cement in the coming decades, and to compare the properties of the new cement with the Portland cement.

The analyzed problem has a scientific and technical interest for the field of materials, engineering and environmental sustainability. The manuscript can be published in this journal if the following points are fully addressed in a revised version.

- General comment

The authors should improve the introduction and the bibliography citing other recent and relevant research papers presented in international journals dealing with this topic.
See for example:

- Papatzani, S., & Paine, K. (2019). Optimization of Low-Carbon Footprint Quaternary and Quinary (37% Fly Ash) Cementitious Nanocomposites with Polycarboxylate or Aqueous Nanosilica Particles. Advances in Materials Science and Engineering, 2019.

- Ferraro, A., Colangelo, F., Farina, I., Race, M., Cioffi, R., Cheeseman, C., & Fabbricino, M. (2020). Cold-bonding process for treatment and reuse of waste materials: Technical designs and applications of pelletized products. Critical Reviews in Environmental Science and Technology, 1-35.

- Minor points:

- Please change the format of Figures' and Tables' captions: it seems the same format of the main text;
- Please improve Figure 5: image is blurry and not clearly visible;
- The heading levels are too similar, so please use consistent formatting (e.g. bold, font size) across the manuscript to indicate different heading levels;
- Please check the font of the tables. Smaller fonts may be used, but no less than 8 pt. in size;
- To make a clearer reading of the paper please put the words "Figure" and "Table" in text in bold style;
- Please check the references, in particular for the journals. They should be described as follows:

1. Author 1, A.B.; Author 2, C.D. Title of the article. Abbreviated Journal Name Year, Volume, page range.

Reviewer #2: As a general rule, the present manuscript followed the routine research aspects to study the physical and chemical properties of five types of waste for cement and new clinker. This study, in which five common wastes were selected for utilization, is a novel and promising idea. However, there are serious problems with the content of the manuscript. Some content in the manuscript is repetitive or unnecessary. The credibility of many conclusions also needs to be improved. The manuscript also lacks the necessary descriptions, such as the specific experimental steps and the need for additional heavy metal leaching experiments in order to reuse the waste. Given this, the manuscript cannot be accepted as its present form. There are some of my suggestions for this manuscript as follows that should be considered.

1. The keyword suggests that all five types of waste be listed.

2. In paragraph 1 of the introduction, the statement that waste is the remnants of production that does not contribute to human life is, in my opinion, biased. Waste is just a misplaced resource. Likewise, there are many wordings in the manuscript that are not strict or even wrong, so please check the manuscript carefully.

3. Data in manuscripts that are not self-researched need additional sources and bases, e.g., "About 60% of the waste production is estimated to be human-based household waste (HW) in Indonesia".

4. In the introduction, although the authors describe in detail the characteristics and status of each waste, they do not reflect the need for these wastes as raw materials for new clinker and cement.

5. The introduction needs to be streamlined and there is a lot of content that is unnecessary. Also, the introduction should add a description of why the four wastes were chosen for this study and what and how they were studied.

6. In Section 2, this section should be supplemented with specific experiments on the proportions and methods by which these wastes are made into cement or new clinker.

7. The manuscript is filled with content that is not relevant to the study. The authors should double-check and streamline the manuscript. For example, in Section 3.3, where are the XRD results of Portland cement particles from 1930 in relation to this study.

8. The composition of the waste, the composition of the cement, and its XRD analysis cannot be called chemical analysis, but still belongs to the category of physical analysis.

9. Since the authors chose these wastes as raw materials to make cement and new clinker, it was necessary to consider the effects of heavy metal contamination.

10. The conclusion is too broad and lacks conclusive sentences. It is suggested that the conclusion should be more specific and representative.

11. Section 5 has little relevance to the study. Please delete it or clearly state the significance of its existence.

12. References should not belong to the sixth section of the manuscript. It should be a separate section.

Reviewer #3: The paper "Physical, chemical properties, and XRD analysis of new clinker and cement made of the burning of quinary by-product" addresses a relevant issue within the scope of development of new cementitious materials, mainly in replacement of traditional Porland Cement, however the paper presents major problems for its acceptance:
a) The title can be improved, I don't see the need to insert the analytical techniques in the title of the paper;
b) The abstract is very simple and with problems, for example, the research objective is twice, the research highlight is not represented, the results and main conclusions are not coherent, the subscript needs to be adjusted (kg/m3);
c) In the introduction, many parts are not cited by the author. A serious problem is the discussion of the innovation of this research! Many other works have already developed cements from solid waste, in which role is this different? The purpose is not even clearly reported to readers in the introduction section.
d) There is a problem in comparing cement and clinker developed with a commercial product, as the production conditions are not the same. The sintering and control of the steps is not precise, and this makes it difficult to validate the data in this study;
e) The clinker development methodology is not clear, was it developed by the authors? And from other research? This is important for comparing results;
f) It is not necessary to indicate the equipment figures;
g) The cement paste consistency method used needs to be explained and justified, there are other methods that could be used;
h) "Moreover, one of the authors [25] is in the article published an interesting and valuable article entitled "Use of ultrafine marble and brick particles as raw materials in cement manufacturing." These two studies and the current study are in agreement with each other because of the all studies support the manufacturing of new hydraulic cements from human-based wastes" This sentence is not well placed, the authors should better explain these works within the literature on the subject;
i) An important parameter for validating the use of this new cement would be its mechanical strength, why didn't the authors do it? Is hydration heat related issues? The authors make no mention of this in the paper.
j) Discussions about setting time are not adequate, note that the parameters that influence the longer or shorter time should be discussed.
k) The conclusion needs to be refined, note that the main quantitative results must be mentioned, as well as the perspectives of this research;
l) Section 5 is not clear, what is your aim? In my view it is in an inappropriate position.

Considering the necessary corrections, I suggest further corrections by the authors for acceptance of this paper.

Gmail Muhammad Syarif <muhsyarif00@gmail.com>

Fw: Enc: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R1

6 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 14 Agustus 2021 04.09
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

My Dear Friend Muhammad:

As you will understand the below email, one reviewer left, who was not convinced. So, if you have SEM analysing of your cement and cement paste and cement concrete materials, please send me its SEM image immediately.

And also, please send me the attached photos with a better resolution.

Thank you in advance.

With my best regards,
Serkan

----- Forwarded Message -----
From: Andre Gustavo de Sousa Galdino <andre.galdino@ifes.edu.br>
To: nakres42@yahoo.com <nakres42@yahoo.com>
Sent: Saturday, August 14, 2021, 01:49:57 PM GMT+3
Subject: Enc: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R1

Hi, Serkan!

Hope everything is going well with you and your family!

Here is the decision about JMRT-01643R1.

I can change itens a), b) and c) (graphs). Can you send me Fig. 4 original file and SEM figures if you have them?

Looking forward to hearing you and working you collaboratively.

My best regards and my best wishes,

André Gustavo de Sousa Galdino, D.Sc.
Professor EBTT
Coordenadoria de Mecânica
Instituto Federal do Espírito Santo – Campus Vitória
27 3331 2100 ramal 2160

sanção disciplinar, cível e criminal.

De: em.jmrt.0.754d46.b37e6950@editorialmanager.com <em.jmrt.0.754d46.b37e6950@editorialmanager.com> em nome de Journal of Materials Research and Technology <em@editorialmanager.com>
Enviado: sexta-feira, 13 de agosto de 2021 23:23
Para: Andre Gustavo de Sousa Galdino
Assunto: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R1

Manuscript Number: JMRT-D-21-01643R1

Physical, chemical properties, and XRD analysis of new clinker and cement made of the burning of quinary by-product

Dear Dr. Galdino,

Thank you for submitting your manuscript to Journal of Materials Research and Technology.

I have completed my evaluation of your manuscript. The reviewers recommend reconsideration of your manuscript following major revision. I invite you to resubmit your manuscript after addressing the comments below. Please resubmit your revised manuscript by Aug 27, 2021.

When revising your manuscript, please consider all issues mentioned in the reviewers' comments carefully: please outline every change made in response to their comments and provide suitable rebuttals for any comments not addressed. Please note that your revised submission may need to be re-reviewed.

To submit your revised manuscript, please log in as an author at https://www.editorialmanager.com/jmrt/, and navigate to the "Submissions Needing Revision" folder.

Journal of Materials Research and Technology values your contribution and I look forward to receiving your revised manuscript.

Kind regards,

Prof. Sergio Neves Monteiro, PhD
Coeditor

Journal of Materials Research and Technology

Reviewers comments:

Reviewer #1: Accepted

Reviewer #3: The authors did a good job of correction and adequacy and answered most of the questions of this reviewer, however some gaps still need to be addressed before the citation of this manuscript, such as:

a) The state of the art of the subject is still restrictive, note that there is a lot of research on supplementary cementitious materials and waste application that can help the interpretation of data from this research, consider improving this section further;
b) The title, although adequate, is too long, this must be modified;
c) Fig. 4 is of low quality, and the others, in the case of graphics, should have the border removed;
d) The authors could present other analytical characterization techniques, such as scanning electron microscopy, to support their discussions and validate their data.

More information and support

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Here you can search for solutions on a range of topics, find answers to frequently asked questions, and learn more about Editorial Manager via interactive tutorials. You can also talk 24/7 to our customer support team by phone and 24/7 by live chat and email

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2 lampiran

CS1.jpg
12K

CS2.jpg
11K

Muhammad Syarif <muhsyarif00@gmail.com> 16 Agustus 2021 14.53
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

My Dear Brother,

Sorry my brother, I've been so busy these days that I didn't have time to open my email.
Regarding the Scanning Electron Microscope (SEM) test. Today is being done. As soon as the results come out I will let you know.
Here I send some photos that might help complete the article.

Regards

Syarif
[Kutipan teks disembunyikan]

---

3 lampiran

Foto Lab - 1.docx
9941K

Foto Lab - 3.docx
2439K

Foto Lab - 4.docx
11931K

Muhammad Syarif <muhsyarif00@gmail.com>
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

16 Agustus 2021 14.57

photo next ...
[Kutipan teks disembunyikan]

Foto Lab - 2.docx
24990K

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

16 Agustus 2021 01.01

Assalamualaikum wr. wb.

My Dear Friend Muhammad:

I whole-heartedly hope that you and your family are very well, and always stay safe, happy, and healthy.

Please send us higher quality of images which are in the email as well as SEM/EDX analysing of your samples.

If it is possible, please put a new cement sample, a Portland cement sample, a new cement paste sample, a Portland cement paste sample, a new cement concrete sample, and a Portland cement concrete sample into the SEM machine so that I could compare them each other. Alright?

Thank you in advance.

With my best regards and my best wishes,
Serkan

[Kutipan teks disembunyikan]

2 lampiran

CS1.jpg
12K

Figure4.jpg
11K

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 18 Agustus 2021 02.34
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

Assalamualaikum wr. wb.

My Dear Friend:

I whole-heartedly hope that you and your family are very well, and always stay safe and healthy and happy.

How about SEM image of your study?

Deadline approached. Please let us get your images.

Thank you in advance.

With my best regards and my best wishes,
Serkan

Sent from Yahoo Mail on Android
[Kutipan teks disembunyikan]

Muhammad Syarif <muhsyarif00@gmail.com> 18 Agustus 2021 02.47
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

Dear my friend

Currently our laboratory is
conducting the SEM process.

God willing, as soon as I'm done I'll send the photo right away.

Regards

Syarif

[Kutipan teks disembunyikan]

Gmail

Muhammad Syarif <muhsyarif00@gmail.com>

One of the most important thing is the XRD graph for article revised. Alright?
6 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 11 Juli 2021 03.10
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

My Dear Brother,

Assalamualaikum.

Because your manuscript_submitted title was published as book chapter in the Elsevier Advance Upcycling Book, we have to rewrite our organic cement article for the JMR&T. I mean that we have only 17 days for submitting of its revisied version.

So, we are primarily in a need of XRD graph which is not blurry. Alright?

Sincerely,
Serkan
PS: In the mean time, your last results in relating to the compressive strength and splitting tensile strength will be perfect for our new article.

Muhammad Syarif <muhsyarif00@gmail.com> 15 Juli 2021 23.30
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

My Dear Brother

Assalamualaikum.
wr..wb

Gmail

Muhammad Syarif <muhsyarif00@gmail.com>

About SEM analysing of new organic cement.
1 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 14 Agustus 2021 07.51
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

Assalamualaikum wr. wb.

My Dear Friend Muhammad:

If you have equipment for SEM analysing at your university, I would like to help new organic cement analyse in the SEM. If it is not possible at your university, please let me get your samples of new organic cement, paste, and concrete with new organic cement and conventional cement. So, I could do analyze of your samples in the SEM equipment here in Turkey.

Please let me get your replying as soon as possible.

With my best regards and my best wishes,
Serkan

Gmail

Muhammad Syarif <muhsyarif00@gmail.com>

about development in new cement article.

10 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 18 Juli 2021 04.31
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

My Dear Brother,

Assalamualaikum wr. wb.

Because I manufactured cement with marble powder and brick powder, I did know the cement which is combination grinding of clinker and gypsum. I mentioned the below paragraph which is quoted from the new cement article.

"To manufacture new cement clinker, the farina prepared by Eq.1 was burned at temperature of 1375 °C. After obtaining the clinker within four hours, it was awaited to cool in the laboratory. The The concentrate-shaped cement material was then subjected to test for examining its chemical structure. In order to assess the compatibility of new cement, the ability to achieve of the chemical structure, the fineness, the density, the initial and final setting-time, and the normal consistency was measured. The empirical equation1 (Eq.1) of the concentrate-forming of new cement can be derived as follows"

Please let me know your gypsum ratio, clinker ratio, and grinding period so that I could help the paragraph change/improve.

I am looking forward to hearing you and collaboratively working you very much.

With my best wishes,
Serkan

PS: Please trust me and send me whatever I want so that we could go further.

Muhammad Syarif <muhsyarif00@gmail.com>
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

18 Juli 2021 04.41

Waalaikumsalam ..wr..wb..

My dear brother

Tomorrow I will send it with the revised JMR&T article.

Regards

Syarif

[Kutipan teks disembunyikan]

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: muhsyarif00@gmail.com

18 Juli 2021 04.48

Alright. Thank you very much.
All the best,
Serkan

Sent from Yahoo Mail on Android
[Kutipan teks disembunyikan]

Muhammad Syarif <muhsyarif00@gmail.com>
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

19 Juli 2021 01.27

Assalamualaikum ..wr..wb..
My Dear Brother

I have revised the article. but there are important things to note:

1. please answer the 3rd reviewer part f and h
2. Please correct the grammar again
3. Please pay attention to the main title
4. Please streamline again if deemed necessary
5. Please add if you think it is necessary to add answers from all reviewers.
5. I have compiled according to the JMR &T Template approach

Thank you My Brother, I hope wish you good health

Regards

Syarif

[Kutipan teks disembunyikan]

2 lampiran

Question .. Answer.docx
1146K

manuscript_REPAIR ....docx
1657K

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 19 Juli 2021 01.30
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: muhsyarif00@gmail.com

Thank you very much my Dear Brother. Alright.
Have wonderful Kurban Bayramı.

All the best,
Serkan

Sent from Yahoo Mail on Android

Reviewers comments:

Reviewer #1:

The objective of the article is to evaluate potential in the burning of waste materials such as household waste, the coal ash waste, Mediterranean soils and calcined clay that are currently not contributing very much in the living conditions of people. The aim is to assess potential manufacture of new form of cement in the coming decades, and to compare the properties of the new cement with the Portland cement.

The analyzed problem has a scientific and technical interest for the field of materials, engineering and environmental sustainability. The manuscript can be published in this journal if the following points are fully addressed in a revised version.

- General comment

Question :

The authors should improve the introduction and the bibliography citing other recent and relevant research papers presented in international journals dealing with this topic.

See for example:

- Papatzani, S., & Paine, K. (2019). Optimization of Low-Carbon Footprint Quaternary and Quinary (37% Fly Ash) Cementitious Nanocomposites with Polycarboxylate or Aqueous Nanosilica Particles. Advances in Materials Science and Engineering, 2019.

- Ferraro, A., Colangelo, F., Farina, I., Race, M., Cioffi, R., Cheeseman, C., & Fabbricino, M. (2020). Cold-bonding process for treatment and reuse of waste materials: Technical designs and applications of pelletized products. Critical Reviews in Environmental Science and Technology, 1-35.

Answer :

From the research conducted by Papatzani et al., it was revealed that for CEMII/A-L (binary) cement, allowable clinker content lies within 80–95% by mass the allowable binder and limestone content is limited to 6–20%. As for Portland-composite cement, namely cement cement which contains the maximum total fly ash and limestone by 35%, the amount of clinker allowed must not be less than 65%. Other Combinations beyond this limit has the potential to cause a series of problems, such as long setup time, compression reduction strength, and inhomogeneous microstructure [16].

The analysis gives a wide overview of the fundamental key-points that control the cold-bonding process. Data comparison provides a useful way to identify the optimal process conditions to allow development of optimum products. This involves the selection of the correct mix-design, including suitable binders and potential additives, and the selection of appropriate operating conditions, which are a function of the waste investigated, and/or waste mix characteristics. The review proposes an optimized approach to experimental studies on cold-bonding processes that has potential to enhance future process performance [17].

In the research, the researchers have produced an organic cement that is the latest alternative cement aside from portland cement which is made through organic waste recycling system, fly ash, bottom ash, and substitution of mediteran soil and clay. The research is oriented to compressive strength, tensile strength, setting time and slump test of concrete by using organic cement and portland cement. Age of concrete in the research are 3, 7, 14, 21, and 28 days. Result for compressive test of cylinder concrete with organic cement, it obtained 14,52 MPa while the cylinder concrete with portland cement, it obtained 22,37 MPa. Result for tensile splitting strength of concrete with portland cement is 2,03 Mpa and cylinder concrete witch organic cement is 1,22 MPa [18].

That from the literature several research results using waste materials including organic waste, fly ash, bottom ash have shown an approach to the physical and mechanical properties of portland cement. As for this study, the use of Mediterranean soil and clay as a source of CaO and SiO2 has been added.

References

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- Minor points:

  - ***Question :***

  - Please change the format of Figures' and Tables' captions: it seems the same format of the main text;

  - ***Answer :***

Figure 1. Various waste and natural raw materials, and new clinker and cement manufactured

Figure 2. The clinkerization from the waste concentrate used in the study

A B C D E

Figure 3. The cement raw material before the combustion process to become the cement concentrate, in image; (A) the Mediterranean soil, (B) the household waste, (C) the calcined clay, (D) the fuel ash, and (E) the bottom ash

(A) (B)

Figure 6. A process of measuring the fineness and the density of cement; new cement (A) and the Portland cement (B) that is used as a comparator in testing the physical properties.

Table 1. Percentage of new cement forming

No	Main composition (Major)				Additional chemical elements (minor)
	Material Source	Major chemical elements	Material Source	Material Used elements	
1.	Mediteran Soil /S	CaO	60,93	54	SiO2, Al2o3, Fe2o3, Mgo, So3, Na2o,K2O
2.	Clay / I	SiO2	30,63	10	SiO2, Al2O3, Fe2O3, CaO, Na2O, K2O, MgO, SO3
3.	Fly Ash / N	SiO2	22,14	4	Al2O3,CaO, Fe2O3, SO3, Na2O, K2O, MnO, MgO, TiO3,
4.	Bottom Ash / A	SiO2	15,20	4	CaO, Al2O3, Fe2O3, MgO, K2O, Na2O,
5.	household waste /R	SiO2	46,65	28	CaO, Al2O3, Fe2O3, MgO, K2O,TiO2, Na2O, P2O5

Table 2. Chemical composition of the wastes used in the study

Chemical compound (%)	Mediterranean soil	Household waste	Calcined clay	Fly ash	Bottom ash
SiO_2	60.93	46.65	30.63	22.14	15.2
Al_2O_3	0.44	2.28	3.41	3.84	2.99
Fe_2O_3	0.15	0.18	0.20	0.20	0.20
CaO	19.35	11.09	0.51	6.87	1.41
SO_3	1.66	1.01	0.36	0.89	0.15
Na_2O	0.01	2.24	0.01	0.37	1.03
K_2O	0.09	11.98	0.23	0.58	0.17
MgO	0.018	0.02	0.02	0.03	0.02
P_2O_5	N/A	0.47	N/A	N/A	N/A
LOI	N/A	N/A	N/A	N/A	N/A

N/A - "Not available"; LOI - "Loss on ignition"

Table 3. Comparison of the chemical analysis results of the new cement concentrate and with that of Portland cement

Chemical compounds (%)	New cement	Portland cement
Alite (C_3S)	69.9	50-70
Belite (C_2S)	7.3	15-30
Tri calcium aluminate (C_3A)	10.3	5-10
Brownmillerite (C_4AF)	3.1	5-15
Silicon oxide (SiO_2)	21.29	20.6

Aluminum oxide (Al_2O_3)	7.86	5.07
Iron oxide (Fe_2O_3)	4.4	2.9
Calcium oxide (CaO)	68.43	63.9
Sulfat oxide (SO_3)	3.2	2.53
Sodium + Potassium oxide Na_2O+K_2O	1.58	0.88
Magnessium oxide (MgO)	4.8	1.53
Loss on Ignition (LOI)	N/A	1.58

Table 4. The fineness of new cement and the Portland cement measured in the experimental study

Type of fineness measure	Type of material	
	New cement	Portland cement
200 (μm) sieve passing (%)	56	52
Specific Surface (kg/m^3)	1200	1250

Table 5. Consistency properties of the new cement and of c Portland cement

Types of cement	Consistency (%)	Penetration depth (mm)	Water demand (g)
New cement	37	25	185
Portland cement	25	24	130

- *Question :*
  - Please improve Figure 5: image is blurry and not clearly visible;
- *Answer :*

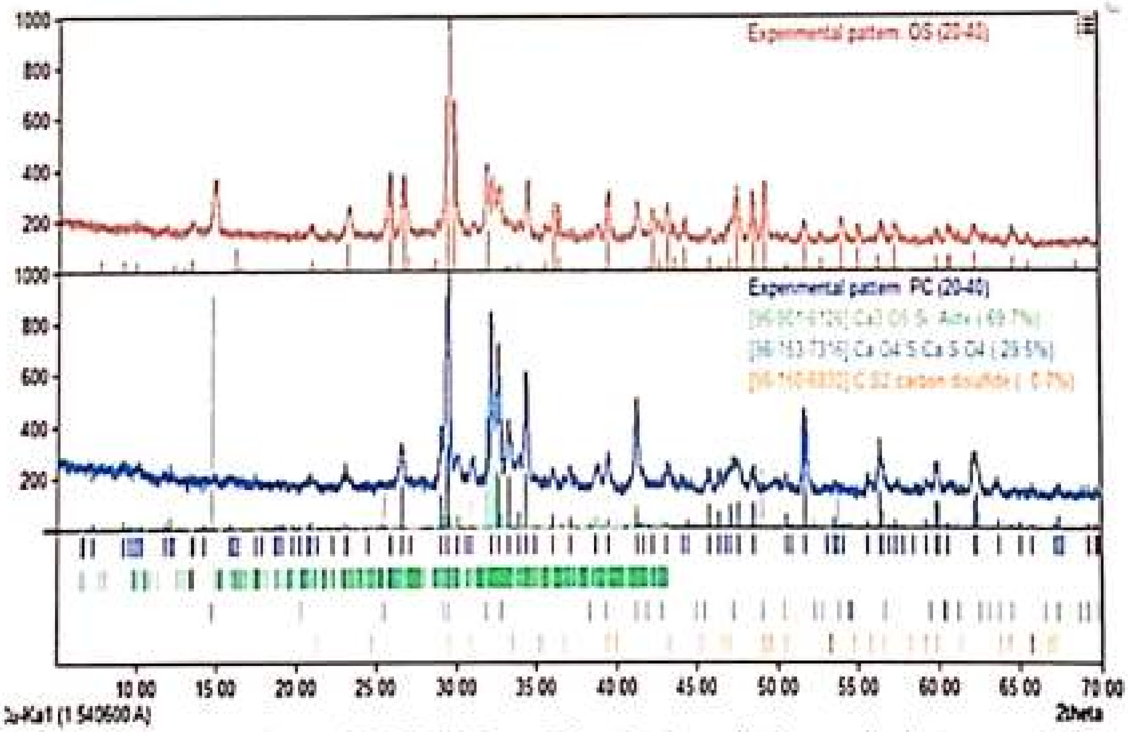

Figure 5. A comparison of XRD (X-Ray Difraction) analysis results between the new cement and Portland cement.

- Question :
  - The heading levels are too similar, so please use consistent formatting (e.g. bold, font size) across the manuscript to indicate different heading levels;
- Answer :

The Physical properties of alternative cement as new cement made from recycling household waste

- Question :
  - Please check the font of the tables. Smaller fonts may be used, but no less than 8 pt. in size;
- Answer :

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Font , 10 PT

Table 1. Percentage of new cement forming

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3.	Fly Ash / N	SiO2	22,14	4	Al2O3,CaO, Fe2O3, SO3, Na2O, K2O, MnO, MgO, TiO3,
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MgO	0.018	0.02	0.02	0.03	0.02
P_2O_5	N/A	0.47	N/A	N/A	N/A
LOI	N/A	N/A	N/A	N/A	N/A

N/A - "Not available"; LOI - "Loss on ignition"

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- *Question :*
  - To make a clearer reading of the paper please put the words "Figure" and "Table" in text in bold style;
- *Answer :*
  - .....is between 6 and 7 [4]. **Figure 1** illustrates.....
  - .... **Figure 2** illustrates. ....
  - .... **Figure 3** shows the ....
  - .... **Figure 4** illustrates the .....
  - .... **Figure 5** shows ....
  - .... **Figure 6** shows ....
  - .... shown in **Table 1** ....
  - .... shown in **Table 2** ....
  - .... **Table 3** gives ....
  - ..... **Table 4** presents ....

- *Question :*
  - Please check the references, in particular for the journals. They should be described as follows:
    1. Author 1, A.B.; Author 2, C.D. Title of the article. Abbreviated Journal Name Year, Volume, page range.

- *Answer :*

[1] Damanhuri Enri, et al., Indonesia Climate Change Sectoral Roadmape (ICCSR) Sektor Limbah, 17 Februari 2011 https://www. bappenas. go.id/files/8913/4986/4554/roadmap-perubahan-iklim-sektor-limbah.

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Reviewer #2:

- ***Question :***

As a general rule, the present manuscript followed the routine research aspects to study the physical and chemical properties of five types of waste for cement and new clinker. This study, in which five common wastes were selected for utilization, is a novel and promising idea. However, there are serious problems with the content of the manuscript. Some content in the manuscript is repetitive or unnecessary. The credibility of many conclusions also needs to be improved. The manuscript also lacks the necessary descriptions, such as the specific experimental steps and the need for additional heavy metal leaching experiments in order to reuse the waste. Given this, the manuscript cannot be accepted as its present form. There are some of my suggestions for this manuscript as follows that should be considered.

- ***Question :***
  1. The keyword suggests that all five types of waste be listed.
  2. In paragraph 1 of the introduction, the statement that waste is the remnants of production that does not contribute to human life is, in my opinion, biased. Waste is just a misplaced resource. Likewise, there are many wordings in the manuscript that are not strict or even wrong, so please check the manuscript carefully.

- ***Answer :***
  1. Mediteran soil, Clay, Fly Ash, Bottom Ash, Household Waste, Portland Cement, Physical and mechanical properties;
  2. – We have revised the repetitive content, especially in the abstract section

Abstract

The purpose of this article is to evaluate the benefits of household waste, coal ash waste (fly ash and bottom ash), Mediterranean soil, and clay which currently have not contributed much to human life. And as a step to save the environment. The results showed that the density of solids was 1200 (kg/m3) lighter than Portland cement, which was 1250 (kg/m3).

The results of the physical characteristic test of the new cement in the form of fresh concrete density is 2081 (kg/m³) with a dry weight of 2032 (kg/m) which is lower than the fresh weight of concrete using Portland cement which is 2525 (kg/m³). The normative reference used is ASTM C 188-95.

The new cement setting time and normal consistency values met the limits set by ASTM C 191-04, ASTM C 191-08 and ASTM C 187-04. The fineness of the new cement indicates that 56% of the grains pass under a 200 mesh sieve, and are thus finer than Portland cement.

To form a new cement concentrate, all the main waste materials are burned at 1375°C for 4 hours. The results of the chemical properties test found similarities to the chemical properties of portland cement

Keywords: Mediteran soil, Clay, Fly Ash, Bottom Ash, Household Waste, Portland Cement, Physical and mechanical properties;

- In our opinion and based on a lot of literature as well as conditions in the midst of people's lives, that garbage so far has not contributed much to human life.
- We have made improvements. Can be seen in the revised article
- We have revised and further sharpened the conclusions

Conclusions

From the results of examination of fineness, density and chemical properties of the new cement, there is resemblance with Portland cement chemical compounds. This can be seen from the XRF (X-Ray Flourencence) and XRD (X-Ray Difraction) test results. The test results of physical properties of cement based on empirical studies approach the normative references on ASTM.

The fineness value of this new cement is finer than Portland cement with a solid weight of 1200 (kg/m3) lighter than Portland cement which reaches 1250 (kg/m3). The specific gravity of Portland cement is 3.15 (g/ml) while the density of new cement is 3.05 (g/ml). The initial setting time of portland cement was obtained 90 minutes where the vikat needle penetrated the cement paste for 24 mm after the needle was removed. The initial setting time of the new cement was also tested by the same method by penetrating 25 mm of cement for 105 minutes after the needle was removed. The final setting time of portland cement is 180 while the new cement reaches 225 minutes

Based on the results of the cement feasibility test, it can be assumed that the cement studied can be used for the work of installing plastering brick walls, floors and so on.

However, it is deemed necessary to conduct further experimental studies to ensure that the cement quality can be as expected based on the American Standard Testing And Material (ASTM) reference. So that in the end the problem of waste and efforts to save the environment from the accumulation of waste can be considered wisely through an experimental study approach as an alternative cement.

- ***Question :***

3. Data in manuscripts that are not self-researched need additional sources and bases, e.g., "About 60% of the waste production is estimated to be human-based household waste (HW) in Indonesia".

- ***Answer :***

Along with economic growth, per capita garbage production will continue to increase so it can be predicted in 2030 will reach 1,2 kg / capita / day for urban areas and 055 kg / person / day for rural areas. In Indonesia, organic waste is a major component of waste. The proportion of organic waste is between 34–70% which is 20–30% higher than most countries in Europe [1]

References

[1] Damanhuri Enri, et al., Indonesia Climate Change Sectoral Roadmape (ICCSR) Sektor Limbah, 17 Februari 2011 https://www. bappenas. go.id/files/8913/4986/4554/roadmap-perubahan-iklim-sektor-limbah.

- ***Question :***

4. In the introduction, although the authors describe in detail the characteristics and status of each waste, they do not reflect the need for these wastes as raw materials for new clinker and cement.

- ***Answer :***

- We have added some explanatory descriptions in the introduction

The purpose of this research article is to provide an understanding of the preservation of environmental safety from waste that does not contribute much to human survival. In this study, the management of household waste along with coal waste in the form of fly ash and bottom ash were substituted with Mediterranean soil and clay as a renewable alternative cement besides Portland cement.

That the results of several literature studies that also use waste materials such as organic waste, fly ash and bottom ash have shown an approach to the physical and mechanical properties of portland cement. As for this research articlerevealed the benefits of household waste, coal waste in the form of fly ash and bottom ash substituted with Mediterranean soil and clay which has shown indications of similarity with portland cement through several experimental studies.

(Additional explanations can be seen at the end of the introduction to the revised article)

- ***Question :***

5. The introduction needs to be streamlined and there is a lot of content that is unnecessary. Also, the introduction should add a description of why the four wastes were chosen for this study and what and how they were studied.

- ***Answer :***

the use of household waste, fly ash/bottom ash, mediterranean soil and clay because from several different research results it is known that each waste has physical and mechanical properties which are indicated to be close to the physical and mechanical properties of portland cement.

6. In Section 2, this section should be supplemented with specific experiments on the proportions and methods by which these wastes are made into cement or new clinker.

- We have added in section 2.2. Research procedures

The percentage of the main ingredients used in the new cement forming is shown in table 1 below.

Table 1. Percentage of new cement forming

No	Main composition (Major)				Additional chemical elements (minor)
	Material Source	Major chemical elements	Material Source	Material Used elements	
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➢ *Question :*

7. The manuscript is filled with content that is not relevant to the study. The authors should double-check and streamline the manuscript. For example, in Section 3.3, where are the XRD results of Portland cement particles from 1930 in relation to this study.

➢ *Answer :*

Has been deleted

3.3 XRD analysis of new cement

Brownmiller and Bogue made the first application of X-ray powder diffraction (XRD) on Portland cement particles in 1930 [29], only discovering the X-rays thirty five years later. At the time of 1930, Portland cement clinker was considered to be composed mainly of either a complex single compound made of lime, alumina, and silica, or separate silicate compounds including various amounts of lime. In their breakthrough study, Brownmiller and Bogue compared X-ray diffraction patterns obtained from a commercial Portland cement clinker to those obtained from individually synthesized phases [29]. The comparison demonstrated the presence of tricalcium silicate (alite) as the primary clinker phase, as suggested previously by Le Chatelier [30, 31] and analysed by Törnebohm [32].

➢ *Question :*

8. The composition of the waste, the composition of the cement, and its XRD analysis cannot be called chemical analysis, but still belongs to the category of physical analysis.

➢ *Answer :*

We call it chemical analysis because the output of XRD testing is a material particle-forming compound. While the physical analysis tends to be the result of testing the use of materials that have been XRD tested.

➢ *Question :*

9. Since the authors chose these wastes as raw materials to make cement and new clinker, it was necessary to consider the effects of heavy metal contamination.

➢ *Answer :*

We have not carried out any research developments on the effects of heavy metals. We will do that in the next research.

➢ *Question :*

10. The conclusion is too broad and lacks conclusive sentences. It is suggested that the conclusion should be more specific and representative.

➢ *Answer :*

From the results of examination of fineness, density and chemical properties of the new cement, there is resemblance with Portland cement chemical compounds. This can be seen from the XRF (X-Ray Flourencence) and XRD (X-Ray Difraction) test results. The test results of physical properties of cement based on empirical studies approach the normative references on ASTM.

The fineness value of the new cement is smoother than Portland cement with a solid weight of 1200 (kg/m3) lighter than Portland cement which reaches 1250 (kg/m3). The density of Portland cement is 3.15 (g/ml) while the density of the new cement is 3.05 (g/ml). The initial setting time of new cement is 105 minutes. By ASTM C 191-19 standard, initial setting time should not be less than 45 (min). The final setting time of Portland cement is at 180 (min), while for new cement is at 225 (min).

Based on the results of the cement feasibility test, it can be assumed that the cement investigated can be used for structural and non-structural work as well as for the installation of brick walls and stucco walls.

However, it is deemed necessary to undertake advanced experimental studies to ensure that the quality of cement can be as expected based on the reference of American Standard Testing And Material (ASTM). So in the end, the problem of waste and the effort of saving the environment from the accumulation of waste can be thought of handling wisely through the approach of experimental study as an alternative

- ***Question :***

11. Section 5 has little relevance to the study. Please delete it or clearly state the significance of its existence.

- ***Answer :***

We apologize, if you mean part 2.5. Finenes of new cement, this is the standard for measuring the fineness of cement based on ASTM C 204-18e1.

And if you mean "Availability of Data and Materials". So we have deleted.

- ***Question :***

12. References should not belong to the sixth section of the manuscript. It should be a separate section.

- ***Answer :***

Has been deleted

6. References

Becomes

References

Reviewer #3:

The paper "Physical, chemical properties, and XRD analysis of new clinker and cement made of the burning of quinary by-product" addresses a relevant issue within the scope of development of new cementitious materials, mainly in replacement of traditional Porland Cement, however the paper presents major problems for its acceptance:

- *Question :*
  a) The title can be improved, I don't see the need to insert the analytical techniques in the title of the paper.

- *Answer :*

The Physical properties of alternative cement as new cement made from recycling household waste

- *Question :*
  b) The abstract is very simple and with problems, for example, the research objective is twice, the research highlight is not represented, the results and main conclusions are not coherent, the subscript needs to be adjusted (kg/m3);

  - *Answer :*

Abstract

The purpose of this article is to evaluate the benefits of household waste, coal ash waste (fly ash and bottom ash), Mediterranean soil, and clay which currently have not contributed much to human life. And as a step to save the environment. The results showed that the density of solids was 1200 (kg/m3) lighter than Portland cement, which was 1250 (kg/m3).

The results of the physical characteristic test of the new cement in the form of fresh concrete density is 2081 (kg/m³) with a dry weight of 2032 (kg/m) which is lower than the fresh weight of concrete using Portland cement which is 2525 (kg/m³). The normative reference used is ASTM C 188-95

The new cement setting time and normal consistency values met the limits set by ASTM C 191-04, ASTM C 191-08 and ASTM C 187-04. The fineness of the new cement indicates that 56% of the grains pass under a 200 mesh sieve, and are thus finer than Portland cement.
To form a new cement concentrate, all the main waste materials are burned at 1375°C for 4 hours. The results of the chemical properties test found similarities to the chemical properties of portland cement

Keywords: Mediteran soil, Clay, Fly Ash, Bottom Ash, Household Waste, Portland Cement, Physical and mechanical properties;

- *Question :*
  c) In the introduction, many parts are not cited by the author. A serious problem is the discussion of the innovation of this research! Many other works have

already developed cements from solid waste, in which role is this different? The purpose is not even clearly reported to readers in the introduction section.

- *Answer :*

The purpose of this research article is to provide an understanding of the preservation of environmental safety from waste that does not contribute much to human survival. In this study, the management of household waste along with coal waste in the form of fly ash and bottom ash were substituted with Mediterranean soil and clay as a renewable alternative cement besides Portland cement.

That the results of several literature studies that also use waste materials such as organic waste, fly ash and bottom ash have shown an approach to the physical and mechanical properties of portland cement. As for this research articlerevealed the benefits of household waste, coal waste in the form of fly ash and bottom ash substituted with Mediterranean soil and clay which has shown indications of similarity with portland cement through several experimental studies.

Added to the introduction

- *Question :*

d) There is a problem in comparing cement and clinker developed with a commercial product, as the production conditions are not the same. The sintering and control of the steps is not precise, and this makes it difficult to validate the data in this study.

- *Answer :*
  - This research is the first step to examine the possibility of using other waste-based materials, apart from the materials generally used for commercial cement (Portland cement) which are currently on the market. So the results obtained are still within the indicated scope of similarity with Portland cement. So it is still considered necessary to carry out research development in the future.

- *Question :*

e) The clinker development methodology is not clear, was it developed by the authors? And from other research? This is important for comparing results;

- *Answer :*
  - This research was conducted by the author

- *Question :*

f) It is not necessary to indicate the equipment figures;

- *Answer :*

....

- *Question :*
  g) The cement paste consistency method used needs to be explained and justified, there are other methods that could be used;

- *Answer :*
  - The method we use for testing the normal consistency is ASTM C 187-04. The description of the method and the results of normal consistency have been described in articles 2.7 and 3.3.3

- *Question :*

  h) "Moreover, one of the authors [25] is in the article published an interesting and valuable article entitled "Use of ultrafine marble and brick particles as raw materials in cement manufacturing." These two studies and the current study are in agreement with each other because of the all studies support the manufacturing of new hydraulic cements from human-based wastes" This sentence is not well placed, the authors should better explain these works within the literature on the subject.

- *Answer :*

  ....
  ....
  ....
  ....

- *Question :*
  i) An important parameter for validating the use of this new cement would be its mechanical strength, why didn't the authors do it? Is hydration heat related issues? The authors make no mention of this in the paper.

- *Answer :*
  - We have not included the mechanical strength of the new cement in this article. We will discuss this in the next article.

- *Question :*
  j) Discussions about setting time are not adequate, note that the parameters that influence the longer or shorter time should be discussed.

- *Answer :*

  - We have added an explanation at the end of 3.3.3 Consistency and setting-time of new cement

That the initial assembly process is slow for the new cement can be considered due to the finer grain size of portland cement as described in section 3.3.1 (fine). This causes the need for water in the binding process to require more than the binding process on portland cement which of course will have an impact on the final binding process on new cement compared to portland cement.

- ***Question :***

k) The conclusion needs to be refined, note that the main quantitative results must be mentioned, as well as the perspectives of this research;

- ***Answer :***

From the results of examination of fineness, density and chemical properties of the new cement, there is resemblance with Portland cement chemical compounds. This can be seen from the XRF (X-Ray Flourencence) and XRD (X-Ray Difraction) test results. The test results of physical properties of cement based on empirical studies approach the normative references on ASTM.

The fineness value of this new cement is finer than Portland cement with a solid weight of 1200 (kg/m3) lighter than Portland cement which reaches 1250 (kg/m3). The specific gravity of Portland cement is 3.15 (g/ml) while the density of new cement is 3.05 (g/ml). The initial setting time of portland cement was obtained 90 minutes where the vikat needle penetrated the cement paste for 24 mm after the needle was removed. The initial setting time of the new cement was also tested by the same method by penetrating 25 mm of cement for 105 minutes after the needle was removed. The final setting time of portland cement is 180 while the new cement reaches 225 minutes

Based on the results of the cement feasibility test, it can be assumed that the cement studied can be used for the work of installing plastering brick walls, floors and so on.

However, it is deemed necessary to conduct further experimental studies to ensure that the cement quality can be as expected based on the American Standard Testing And Material (ASTM) reference. So that in the end the problem of waste and efforts to save the environment from the accumulation of waste can be considered wisely through an experimental study approach as an alternative cement.

- ***Question :***

l) Section 5 is not clear, what is your aim? In my view it is in an inappropriate position.

- ***Answer :***

If you mean "Availability of Data and Materials". So we have deleted.

- ***Question :***

Considering the necessary corrections, I suggest further corrections by the authors for acceptance of this paper.

- ***Answer :***

  We have fixed and made improvements. Hopefully it's what you expect

The Physical properties of alternative cement as new cement made from recycling household waste

Muhammad Syarif[1], Mehmet Serkan Kırgız[2], André Gustavo de Sousa GALDINO[3], John Kinuthia[4], Jamal KHATIB[5]

[1] Muhammadiyah Makassar University of Indonesia, IDN
[2] Engineering Faculty, İstanbul University-Cerrahpaşa, Avcılar 34320, İstanbul, TR
[3] Federal Institute of Education, Sciences and Technology of Espirito Santo, Av. Vitória, 1729, Jucutuquara, Vitória, ES, 29040-780, BR
[4] Advanced Materials Testing Centre (AMTeC), University of South Wales, South Wales, UK
[5] Department of Civil and Environmental Engineering, Faculty of Engineering, Beirut Arab University, Lebanon

Abstract

The purpose of this article is to evaluate the benefits of household waste, coal ash waste (fly ash and bottom ash), Mediterranean soil, and clay which currently have not contributed much to human life. And as a step to save the environment. The results showed that the density of solids was 1200 (kg/m3) lighter than Portland cement, which was 1250 (kg/m3).
The results of the physical characteristic test of the new cement in the form of fresh concrete density is 2081 (kg/m³) with a dry weight of 2032 (kg/m) which is lower than the fresh weight of concrete using Portland cement which is 2525 (kg/m³). The normative reference used is ASTM C 188-95
The new cement setting time and normal consistency values met the limits set by ASTM C 191-04, ASTM C 191-08 and ASTM C 187-04. The fineness of the new cement indicates that 56% of the grains pass under a 200 mesh sieve, and are thus finer than Portland cement.
To form a new cement concentrate, all the main waste materials are burned at 1375°C for 4 hours. The results of the chemical properties test found similarities to the chemical properties of portland cement

Keywords: Mediteran soil, Clay, Fly Ash, Bottom Ash, Household Waste, Portland Cement, Physical and mechanical properties;

1. Introduction

The purpose of this research article is to provide an understanding of the preservation of environmental safety from waste that does not contribute much to human survival. In this study, the management of household waste along with coal waste in the form of fly ash and bottom ash were substituted with Mediterranean soil and clay as a renewable alternative cement besides Portland cement.

That the results of several literature studies that also use waste materials such as organic waste, fly ash and bottom ash have shown an approach to the physical and mechanical properties of portland cement. As for this research articlerevealed the benefits of household waste, coal waste in the form of fly ash and bottom ash substituted with Mediterranean soil and clay which has shown indications of similarity with portland cement through several experimental studies.

Garbage is the rest of the production that has not been maximally utilized in human life. In particular, waste is seen as a something that does not have a positive impact on people, but it has a huge influence on the continuation of human life. Improper waste handling would lead to unhealthy environmental patterns and damage the ecosystem. At present, the problem of waste becomes a world problem, and, since two decades, various ways have been tried by people as a step to save the environment from negative effect that can be caused by waste.

Along with economic growth, per capita garbage production will continue to increase so it can be predicted in 2030 will reach 1,2 kg / capita / day for urban areas and 055 kg / person / day for rural areas. In Indonesia, organic waste is a major component of waste. The proportion of organic waste is between 34–70% which is 20–30% higher than most countries in Europe [1]

Integrated waste management from source to downstream could minimize the impacts arising from waste such as the emergence of various diseases and environmental contamination, including in the water, air, and soil. With its good management, the waste would actually be a useful resource of raw material for various industries such as cement, tile, brick, and also energy [2]. Makassar as one of the major cities in Indonesia is generated waste of 4000 m^3/d [3]. Another material does not contribute to human life is the Mediterranean soil is often known as rocky soil. This is due to its lime content that is high enough to make it very difficult for plant to grow. Increased demand for housing and infrastructure automatically increases the need for building materials. Growth related to building material demand requires to be addressed by conducting research on the utilization and development of new building materials that are capable of being alternative materials. The current experimental research relates to this matter, by substituting Mediterranean and clay soils with waste in a recycling system of waste that uses household waste, coal waste (fly ash and bottom ash) to form new cement and new cement paste composite which would be alternative to Portland cement. The following paragraphs summarize the aforementioned wastes and materials as constituent materials for new cement and paste composite.

Mediterranean soils, forming under a Mediterranean climate, are variously called the Terra Rossa Soil on hard limestone and Red Mediterranean Soil. However, whole soils are not classified as such in a Mediterranean environment because significant erosion, lack of clean water, unfavorable mineral characteristics, coherence, and permeability may hamper the development of regular Mediterranean soil formation process [4]. The variety of soils is very wide in the Mediterranean region, but the carbonaceous soils seem to be the most common land materials. Throughout the Mediterranean Sea, the calcareous sedimentary soils such as limestone soils, dolomitic soils, and marl soils have various features in terms of hardness, mineralogical composition, and permeability. In South Africa and Australia, non-calcareous sedimentary soils including sandstone, mudstone and shale are well known. In addition, the granite as plutonic mac, the basalt as volcanic mac, and quartzite and gneiss as metamorphic mac are abundant in the region. The soils have various chemical structures, and each behaves differently in terms of solubility when subject to disintegration and weathering [4]. The mineralogical structures in carbonaceous soil starts with a chemical attack and dissolution of calcium carbonate by penetrating rain water and freeze-thawing cycles, especially when enriched by the CO_2 and plant root system:

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

$$CaCO_3 + H_2CO_3 \longrightarrow Ca(HCO_3)_2$$

The insoluble calcium carbonate ($CaCO_3$) firstly meets with carbonic acid (H_2CO_3) in environment, and the carbonate is converted into soluble calcium bi carbonate ($Ca(HCO_3)_2$) which is then removed by drainage water in the foundation. The dissolution of the soil leaves behind a fresh product from the $CaCO_3$, whose properties depend on the natural environment, the hardness of the substrate, and the level of chemical aggressiveness of the water that leaches through the soil [4]. This would be referred to as decrease of soil pH from 8-8.2 range to 7-7.2 range, and a reduction tendency towards a de-saturation of the caution exchange complex. On non-carbonaceous and acid layer, like granites, gneiss or sandstones, as natural leaching and plant acid root system escalate the acidity and desaturation during the winter period, the soil pH is between 6 and 7 [4]. Figure 1 illustrates various waste and natural raw materials, and new clinker and cement manufactured.

Figure 1. Various waste and natural raw materials, and new clinker and cement manufactured

In addition to the Mediterranean soil, the amount of household waste (HW) increased very rapidly because of rapid growth in urbanization and industrialization. In addition to the growth, in near future, since people continue to increasingly generate the HW and the lack of landfill regions for the HW, together with increasing of cost for landfill operating of the HW, its disposal is becoming a very significant problem for most communities. With increasing of environmental awareness and the potential hazardous effect of the HW, the recycling of HW is becoming an immense interest, instead of the disposal of HW. Ash from energy power station (EPS) could possibly be used in concrete manufacturing. There is plenty of much paper reports further detail about the physical, chemical, and mineralogical composition, and elemental analysis of the ash of EPS. They include the effect of EPS ash on the compressive strength, chloride resistance, and shrinkage of concrete. They also deals with the leachate analysis of ash of EPS [5]. A study, entitled "Recycling of municipal solid waste for cement production: pilot-scale test for transforming incineration ash of solid waste into cement clinker", carried out by Kikuchi in 2001 showed that the quality of the resulting cement is sufficient to enable the cement to be put to practical use in construction. Furthermore, the tested process does not result in secondary pollution. Consequently, the study reported that approximately 50% of the raw material used in cement manufacturing would be obtained from the incineration ash of HW [6]. Another study published by Belie et al in 2018 explained that huge amounts of the HW were being generated, and even though the incineration process reduced the mass and volume of the HW to a large extent, a massive quantity of residue of HW still remained. On average, out of 1.3 billion tons of the HW generated per year, around 130 million tons were incinerated in the world. About 400 kT of bottom ash residues were generated in Flanders the previous year, out of which only 102 kT were utilized, and the rest exported or landfilled due to non-conformity to environmental regulations. The landfilling makes the valuable resources in the HW unavailable and results in large quantities of primary raw material being used, increasing mining activities and related hazards. Identifying and employing the right pre-treatment techniques for the HW is the key to attaining a circular economy. Uses of the HW in the cement industry as a binder and cement raw meal replacement are identified as possible effective utilization options for large quantities of bottom ash of HW. With all the research evidence available, there is now a need for combined efforts from incineration and the cement industry for technical and economic optimization of the process flow of HW [7].

However, there are many reports on the use of the calcined clay for cement manufacturing. It is reported that the cement industry could substitute the pozzolanic and latent hydraulic cementitious constituents for Portland cement clinker to provide a holistic approach for reduction of CO_2 emission effect on the environment. It is clear that due to significant increase in demand for cement, calcined clay is becoming much important for the cement manufacturing as a valuable pozzolanic constituent. It is possible to use calcined clay in cement as main constituent in regard to EN 197-1 if the percent of the reactive silicon dioxide is not lower than 25% by mass. Particularly, the effect of the chemical and mineralogical composition of the clay on their suitability as a main constituent in cement has not yet been sufficiently evaluated. The compressive strength tests on the CEM II/A-Q were carried out with a water-to-cement ratio of 0.5, and on the CEM IV/B (Q) with a water-to-cement ratio of 0.6 for process-related reasons. The strengths of the CEM II/A-Q were between approximately 21 (MPa) and approximately 29 (MPa) at the age of 2 days and between approximately 48 (MPa) and approximately 66 (MPa) at the age of 28 days. The strengths of the CEM IV/B (Q) were between approximately 9 (MPa) and approximately 13 (MPa) at the age of 2 days and between approximately 24 (MPa) and approximately 49 (MPa) at the age of 28 days. The highest levels of compressive strength were reached with the kaolinite clays [8]. Therefore, another of the objectives of the study is, through experimental laboratory research and development, to better explain the suitability of the calcined clay in using for cement making process.

Pulverized fuel ash (PFA) is also used in the study. The manufacturing of Portland cement composite concrete uses pulverized fuel ash as a supplementary cementitious material (SCM) [9]. The use of SCM overcomes various negative chemical problems, and contributes to the physical and mechanical features of the hardened cement based material through enhanced its hydraulic and pozzolanic activity. Pulverized fuel ash is defined as a SCM, and is classified differently in regard to various institutions such as the ASTM and the CSA in various countries. The specification of the ASTM depends on the chemical composition of the PFA. The standard stipulates that the sum of SiO_2 + Al_2O_3 + Fe_2O_3 oxide has to be more than 70%. The anthracite or bituminous coal fuel ash is referred to as Class F fuel ash. If its oxide of SiO_2 + Al_2O_3 + Fe_2O_3 sum is less than 50% in composition, the lignite or sub-bituminous coal fuel ash is referred to as Class C fuel ash. While the ASTM evaluates the PFA as two classes, the CSA lays down the PFA as three classes. According to classification of the PFA by the CSA, the F type fuel ash contains calcium (CaO) oxide content lower than 8%. The second type called the CI fuel ash includes CaO content between 8% and 20%. The last type is the CH fuel ash and comprises of CaO content of more than 20%. The PFA has notable benefits on cement-based composite material (CBCM). This following paragraphs summarize its benefits on CBCM systems [9, 10]. PFA reduces the water demand of CBCM, and thus accordingly, the use of good quality fuel ash along with the high fineness and low CaO content may allow the composite concrete to be mixed at a lower water quantity when compared to the Portland cement composite concrete manufactured at same workability. High dosage level fuel ash by mass of total cement binder along with low water content may eliminate the bleeding and segregation because of pozzolanic activity of the PFA. The substitution level of the low CaO Class F fuel ash for the Portland cement increases the early-age compressive strength gain decreasing in the CBCM, but it shows a positive effect on the compressive strength gain in the long term [9, 10]. The benefits list of pulverized fuel ash is long. Coal burning results not only in PFA, but also in bottom ash that is generated by various industries that require high temperatures in their manufacturing. The bottom ash's mechanical properties are thoroughly studied in several countries. There is a regularly need to consider the quality of the bottom ash, in order to enhance its use as a suitable substitution material for fine aggregate and course aggregate in CBCM as well as a sub-ground material for infrastructure. Because of mineralogical and geochemical changes, bottom ash's pH varies between 8 and 11. For all possible types of utilization of bottom ash, it is very beneficial for the mechanical properties to consider heavy metallic content prior to utilization. Removing all metals creates a homogenous and mechanically strong material. Furthermore, other uses are being investigated. An example of other uses is in low tensile strength composite concrete, such as outdoor tiles. The use of bottom ash for composite concrete is quite substantial in modern society; hence, large markets for bottom ash utilization exist [9, 10].

The need for new building material due to growth in population must be addressed with the use and discovery of new building materials that are capable of being alternatives to current building materials. Cement is the newest alternative for the Portland cement which is the experimental research that has been made utilizing various forms of recycling and utilization of waste. The aim of the new cement is to use ingredients such as the HW, the PFA, bottom ash, Mediterranean soil, and calcined clay. The lack of research on the making new cement with coal waste such as PFA and bottom ash that inspires the researchers all over the world to conduct new experimental studies that show-case how the waste can be utilized for human interest in construction and development of structure and infrastructure. The PFA and bottom ash are the examples of waste that can be utilized in cement production. It is, however, necessary to pay attention to the properties and content of cement used in composite concrete. Research suggests that the use of fly ash that is extensive in cement clinkerization, and its partial replacement for cement will lead to reduction of heat of hydration. Therefore, it slows down the chemical reactions in the hydration of cement, and it accelerates the setting-time of cement as well [11].

The use of the PFA as an additional material and the SCM is often referred to as composite cement in the Portland cement industry. The use of PFA is a wise step in the cement manufacturing because it has amorphous silica content and its reuse provides limitless recycling opportunities for both composite cement and energy. With a high silica content, the PFA meets the characteristics of cement and pozzolanic latent material [12]. The use of saturated PFA is one of the ways to reduce high exposure in the hydration process against the density of cement in composite concrete [13]. The setting-time of cement is the starting process of a chemical compound reaction that occurs in cement just after the cement reacts with water so that the composite cement can become hard and withstand pressure. The use of the PFA leads to a reduction in air pollution that impacts the economy negatively. It has been observed that 0.9 tons of CO_2 is produced per ton of cement production. In addition, the cement composition is 10% by weight in cubic units of composite concrete. Thus, the use of the PFA, bottom ash, household waste, Mediterranean soil, and the calcined clay makes new composite cement possible to help reduce atmospheric CO_2 emissions as a form of eco-friendly engineering and design [14]. The effect of adding a certain quantity of the waste will increase the strength of cement based composite [15].

From the research conducted by Papatzani et al., it was revealed that for CEMII/A-L (binary) cement, allowable clinker content lies within 80–95% by mass the allowable binder and limestone content is limited to 6–20%. As for Portland-composite cement, namely cement cement which contains the maximum total fly ash and limestone by 35%, the amount of clinker allowed must not be less than 65%. Other Combinations beyond this limit has the potential to cause a series of problems, such as long setup time, compression reduction strength, and inhomogeneous microstructure [16].

The analysis gives a wide overview of the fundamental key-points that control the cold-bonding process. Data comparison provides a useful way to identify the optimal process conditions to allow development of optimum products. This involves the selection of the correct mix-design, including suitable binders and potential additives, and the selection of appropriate operating conditions, which are a function of the waste investigated, and/or waste mix characteristics. The review proposes an optimized approach to experimental studies on cold-bonding processes that has potential to enhance future process performance [17].

In the research, the researchers have produced an organic cement that is the latest alternative cement aside from portland cement which is made through organic waste recycling system, fly ash, bottom ash, and substitution of mediteran soil and clay. The research is oriented to compressive strength, tensile strength, setting time and slump test of concrete by using organic cement and portland cement. Age of concrete in the research are 3, 7, 14, 21, and 28 days. Result for compressive test of cylinder concrete with organic cement, it obtained 14,52 MPa while the cylinder concrete with portland cement, it obtained 22,37 MPa. Result for tensile splitting strength of concrete with portland cement is 2,03 Mpa and cylinder concrete witch organic cement is 1,22 MPa [18].

That from the literature several research results using waste materials including organic waste, fly ash, bottom ash have shown an approach to the physical and mechanical properties of portland cement. As for this study, the use of Mediterranean soil and clay as a source of CaO and SiO2 has been added.

2. Research methodology

In testing and evaluating of new clinker concentrate, the comparative study analysis chemical compounds of the Mediterranean pozzolanic soil, the household waste, the calcined clay, the pulverized fuel ash, the bottom ash, and new cement clinker manufactured the waste, and measures the physical properties of new cement to examine the level of similarity and difference between the Portland cement and new cement. In every new cement study, the testing of chemical properties must be done on each raw material that has been processed to concentrate and form of cement. After that, physical testing on new cement concentrate was carried out. To obtain optimum result, the methods used are based on the reference to American Standard Testing and Materials (ASTM) in testing and evaluating the chemical properties of the Mediterranean pozzolanic soil, the household waste, the calcined clay, the pulverized fuel ash, the bottom ash, and the new cement clinker manufactured from the wastes, and such physical properties of the new cement as density and fineness as well as the setting-time of new cement composite paste.

2.1 Tools and materials used

New cement concentrate is formed by utilizing the management of waste recycling, such as utilisation of household waste by substitution of Portland cement using Mediterranean soil, clay, fly ash, and bottom ash. Figure 2 illustrates the clinkerization from the waste concentrate used in the study.

Figure 2. The clinkerization from the waste concentrate used in the study

The combustion of raw material is conducted in a box fire machine that can withstand heat up to 1800 °C. The temperature control of combustion was carried out using a TI-1500 infra red sanfix thermometer tool. Figure 3 shows the cement raw material before the combustion process to become the cement concentrate.

Figure 3.The cement raw material before the combustion process to become the cement concentrate, in image: (A) the Mediterranean soil, (B) the household waste, (C) the calcined clay, (D) the fuel ash, and (E) the bottom ash

To analyze the setting-time of new cement composite paste, the Vicat tool was used. To analyze the fineness of new cement, the Blaine tool was used. The examination of chemical compounds of the wastes and new cement was conducted at a chemistry laboratory, while the physical properties of new cement were established in a construction material laboratory in Indonesia.

2.2. Research procedures

To form a new cement concentrate, all the main waste materials are burned to a temperature of 1375°C for 4 hours,, the cooling and refinement was performed. The concentrate-shaped cement material was then subjected to test for examining its chemical structure. In order to assess the compatibility of new cement, the ability to achieve of the chemical structure, the fineness, the density, the initial and final setting-time, and the normal consistency was measured. The empirical equation1 (Eq.1) of the concentrate-forming of new cement can be derived as follows:

The empirical Equation1 (Eq.1) of the concentrate-forming of cement can be derived as follows:

$$\sum R_{If} = \frac{\sum S + \sum I \sum N \sum A \sum R}{100} \qquad \text{Eq.1}$$

Where:

∑R*If* = Cement concentrate (kg)
∑S = Mediterranean soil concentrate (%)
∑I = Soil concentrate (%)
∑N = Household waste concentrate (%)
∑A = Fly ash concentrate (%)
∑R = Bottom ash concentrate (%)

The percentage of the main ingredients used in the new cement forming is shown in table 1 below.

Table 1. Percentage of new cement forming

No	Main composition (Major)				Additional chemical elements (minor)
	Material Source	Major chemical elements	Material Source	Material Used elements	
1.	Mediteran Soil /S	CaO	60,93	54	SiO2, Al2o3, Fe2o3, Mgo, So3, Na2o,K2O
2.	Clay / I	SiO2	30,63	10	SiO_2, Al2O3, Fe2O3, CaO, Na2O, K2O, MgO, SO3
3.	Fly Ash / N	SiO2	22,14	4	Al2O3,CaO, Fe2O3, SO3, Na2O, K2O, MnO, MgO, TiO3,
4.	Bottom Ash / A	SiO2	15,20	4	CaO, Al2O3, Fe2O3, MgO, K2O, Na2O,
5.	household waste /R	SiO2	46,65	28	CaO, Al2O3, Fe2O3, MgO, K2O,TiO2, Na2O, P2O5

2.3. Chemical analysis of the wastes and new cement

Before mixing of the wastes together to make new cement concentrate, a recent study established the chemical composition of the Mediterranean pozzolanic soil, the household waste, the calcined clay, the fuel ash, and the bottom ash in accordance with the ASTM C114-07 standard wet chemical analysis method [19]. The chemical composition of the new cement composition was determined using the Energy Dispersive X-Ray Fluorescence method suggested by Wheeler in 1983 [20].

2.4. XRD analysis of new cement manufactured

Using ASTM C1365-18 (1998), numerous comprehensive studies were carried out on the mineralogy of cement [21]. Figure 4 illustrates the XRD equipment, which was used to identify the major part and definition of the diffraction angle 2θ, in the study.

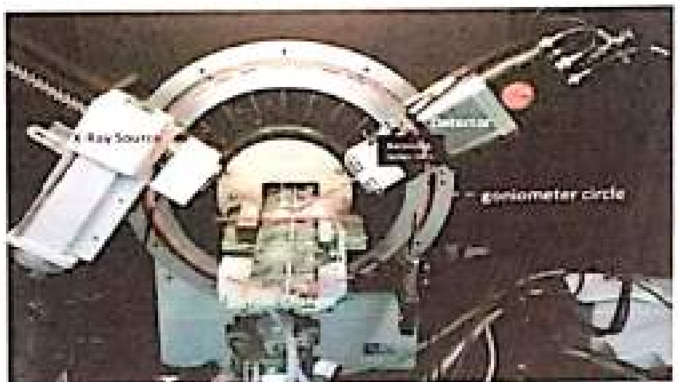

Figure 4. The XRD equipment, which was used to identify the major part and definition of the diffraction angle 2θ, in the study

Theoretical equations of Bogue calculation and such Bogue chemical compounds as the C_3S and the C_2S and the C_3A and the C_4AF have created some debate regarding on the strength mechanism of Bogue chemical compounds. In the light of the debate, the studies evaluate the mineralogy of new cement using X-ray powder diffraction (XRD) in accordance with ASTM C1365-18 [21]. Diffraction deals with constructive interference of X-rays scattering from a sample, and follows Bragg's law through equation 2 (Eq.2).

$$\theta = arcsin\left(\frac{n\lambda}{2d}\right) \quad \text{Eq.2}$$

Where the θ is a diffraction angle indicated in the study, the n is a constant, the λ is a wavelength of the X-ray scattered from new cement, and the d is a distance between two adjacent parallel lattice planes in the inner crystal structure [21].

2.5. Fineness of new cement

In order to determine the quantity of cement particle lower than 200 (μm) in size, the fineness test of new cement was carried out using the sieve of 200 (μm) mesh. The fineness of the new cement was determined in accordance with ASTM C 204-18e1 standard method [22]. The study applied the following summary steps: (1) obtaining a representative sample of new cement, (2) rubbing the new cement between the hands to break up the lumps, (3) weigh and record 100 (g) sample of new cement as (W_1), (4) pour 100 (g) of new cement on to the sieve of 200 (μm) mesh, and place the lid, (5) shake the sieve for 15 (min), including in planetary and linear movements, (6) weigh the residue retained on the sieve of 200 (μm) mesh, and record as (W_2), (7) calculate the percentage of weight of cement retained on the sieve (W_t) as in the equation 3 (Eq.3) [22]. The study repeated the above steps of fineness experiment with three different samples of new cement, and recorded the fineness results to calculate the average value.

$$W_t = \frac{W_2}{W_1} x\ 100 \qquad \text{Eq.3}$$

2.6. Density of new cement

In order to establish the density of new cements and the Portland cement, the study used the rules of standard method specified in the ASTM C 188-95 [23]. For that aim, the following steps were engaged in the test; (1) weigh a clean and dry the Le Chatelier flask (W_1), (2) fill new cement sample upto half of the flask (about 50 mg), (3) weigh the Le Chatelier flask along with the sample (W_2), (4) put kerosene in the flask until the flask was about half full, (5) mix thoroughly with glass rod to remove the entrapped air, (6) proceed the mixing and add more kerosene until the flask is flush with the graduated mark, (7) dry the outside and wiegh again (W_3), (8) remove the flask and dry and fill the kerosene with the graduated mark, (9) dry the flask outside and weigh (W_4) [22]. The following equation 4 (Eq. 4) calculates the density as it is:

$$\gamma = \frac{(W_2 - W_1)}{[(W_2 - W_1) - (W_3 - W_4)] x\ 0.79} \qquad \text{Eq.4}$$

In the Eq. 4, the symbol of γ stands for the density of cement as (g/cm^3), and the number of 0.79 stands for the density of the kerosene used.

2.7. Consistency of new cement paste

The consistency of cement paste test is performed to determine the water demand that is to be added in cement to attain normal consistency of cement paste composite. The study used the ASTM C 187-04 standard method [24] to assess the consistency of new cement composite paste. Its steps may be summarized as follows; (1) get 400 (g) of new cement and place it in a bowl to prevent humudity, (2) assume standard consistency of water is 28% and add the same quantity of water in cement and mix it, (3) mix the cement composite paste thoroughly between 3-5 (min), (4) fill the cement composite paste in the Vicat mould correctly, (5) then, place the Vicat mould on the glass plate, (6) check that the plunger should touch the surface of Vicat mould gently, (7) release the plunger and allow it to sink into the test mould, (8) record the penetration of the plunger from the bottom of mould indicated on the scale, (9) repeat the same experiment by adding different percentages of water until the penetration of plunger is in between 5-7 (mm) on the Vicat apparatus scale [24]. The study repeated the above steps of consistency experiment using three different samples of cement composite paste, and recorded the consistency results to calculate the average value accurately. The importance of the consistency test stems from the fact that when water is mixed with cement, its hydration process starts. Surplus addition of water in cement leads up to an increase in water-to-cement ratio, and the increased water reduces the strengt1h of cement paste after it hardens. If less water is added than required, the cement paste composite is not properly hydrated, and the insufficient water content leads up to the loss on strength, especially compressive strength.

2.8. Setting-time of new cement paste (Initial and Final)

When cement is mixed with water, it makes cement paste that results in hydration products. The paste can be moulded into any desired shape due to its workability. Within its setting-time, the cement composite paste proceeds with reaction, further mixing the water and slowly the cement composite paste starts losing its workability to set and harden. This whole cycle is called the setting-time of cement composite paste. There are two periods known as initial and final setting-times. The study used the ASTM C 191-19 standard method [25] to measure the setting-time of cement composite paste as summarized as following; (1) weigh 400 (g) of new cement and place it in a bowl to prevent humudity, (2) add water by three fifths (3/5) millilitre of weight of cement in bowl, (3) mix the water and cement sample in the bowl, (4) fill the mix in Vicat mould, (5) then, place the Vicat mould on the special glass plate, (6) check that the plunger of Vicat equipment should touch the surface of Vicat mould gently, (7) Release the plunger and allow it to sink into the test mould, (8) record the penetration of the plunger from the bottom of mould indicated on the scale, (9) repeat the same penetration at different positions on the mould until the plunger should stop penetrating 5 ± 2 (mm) from the bottom of the mould. At 5 ± 2 (mm) penetration, this time is recorded as the initial time of setting of the cement composite paste [24]. After starting setting-time of cement composite paste, replace the plunger with one with an annular attachment. The time period between the moment water is added to the cement and the time at which the needle makes an impression on the surface of the cement composite paste, while the attachment fails to do so, is recorded as the final setting time of cement composite paste [25].

3 Results and discussions

The new research that has been conducted includes XRF and XRD analyses on new cement concentrate as well as some physical properties such as granular fineness, specific surface, bulk density, consistency, and setting-time of new cement.

3.1 Chemical composition of the wastes

The wet chemistry, also known as the brench method and wet analysis, is current and certain method to determine chemical composition of bulk materials such as waste, cement, lime, gypsum. It conventionally uses such reagents and tools as acid, beakers and flasks to decompose the solid and/or bulk sample in a liquid, and identifies and quantifies the elements in the sample through various calculation technics and instrumentation. If it is necessary, the technic of separation and isolation is applied to the sample. The stoichiometric method, such as the gravimetric method and the volumetric method is used in the wet chemical analysis, enabling the chemical analysis of the sample quantatively. There are two wet chemical analysis types, the qualitative analysis identifies which elements exist in the sample and the quantitative analysis determines the quantity of elements in the sample. The chemical analysis results of various wastes used in the manufacturing of cement concentrate is shown in Table 2.

Table 2. Chemical composition of the wastes used in the study

Chemical compound (%)	Mediterranean soil	Household waste	Calcined clay	Fly ash	Bottom ash
SiO_2	60.93	46.65	30.63	22.14	15.2
Al_2O_3	0.44	2.28	3.41	3.84	2.99
Fe_2O_3	0.15	0.18	0.20	0.20	0.20
CaO	19.35	11.09	0.51	6.87	1.41
SO_3	1.66	1.01	0.36	0.89	0.15
Na_2O	0.01	2.24	0.01	0.37	1.03
K_2O	0.09	11.98	0.23	0.58	0.17
MgO	0.018	0.02	0.02	0.03	0.02
P_2O_5	N/A	0.47	N/A	N/A	N/A
LOI	N/A	N/A	N/A	N/A	N/A

N/A - "Not available"; LOI - "Loss on ignition"

Almalkawi et al. in 2019 reported a very significant study on the industrial waste for using new geopolymer binder as green construction materials. The authors needed to identify the chemical composition of the new geopolymer binder as the chemical composition of the waste plays significant role on the properties and development of new hydraulic geopolymer binder. Results of the study show the science community that ternary blend of combustion ashes could be used to manufacture hydraulic geopolymer binders of targeted strength and the upcycling of wastes safely [26]. A similar study has been performed on waste packing glass bottle, and reported by Ibrahim and Meawad in 2018 [27]. Researchers in the current study needed to determine the chemical composition of waste, and they applied the wet chemistry to the waste. The study contributes to better understanding that the powder of uncolored, green and brown soda-lime glass types that are available to be used as supplementary cementitious materials, and the ions responsible for their color do not have effect on their performance.

ASTM C618 defines that fly ash pozzolan utilized should contain silicon oxide (SiO_2) + aluminum oxide (Al_2O_3) + iron oxide (Fe_2O_3) ≥ 70 wt.%. In the current study, the content of SiO_2, Al_2O_3, Fe_2O_3 and calcium oxide (CaO) suggest valuable chemical composition and potential for latently hydraulic material, and will enable slow strength development, for clinker, cement, and cement based materials. Other studies stand for the necessity of the chemical composition identification for new cement and conventional cement. One of them is a current study published by Ruiz-Sánchez et al in 2019, entitling Waste marble dust: An interesting residue to produce cement [28].

This study makes six clinker types with waste marble dust. To understand their chemistry, the study performs the wet chemical analysis on them. Its results reveal that the mineralogical composition of waste marble dust is based on the presence of CaO, and its physicochemical analysis confirmed its feasibility as a pure and clean by-product. Moreover, one of the authors [29] is in the article published an interesting and valuable article entitled "Use of ultrafine marble and brick particles as raw materials in cement manufacturing." These two studies and the current study are in agreement with each other because the all studies support the manufacturing of new hydraulic cements from human-based wastes.

3.2 Chemical composition of new cement

The chemical analysis results of cement concentrate and Portland cement, and their comparison are shown in Table 3.

Table 3. Comparison of the chemical analysis results of the new cement concentrate and with that of Portland cement

Chemical compounds (%)	New cement	Portland cement
Alite (C_3S)	69.9	50-70
Belite (C_2S)	7.3	15-30
Tri calcium aluminate (C_3A)	10.3	5-10
Brownmillerite (C_4AF)	3.1	5-15
Silicon oxide (SiO_2)	21.29	20.6
Aluminum oxide (Al_2O_3)	7.86	5.07
Iron oxide (Fe_2O_3)	4.4	2.9
Calcium oxide (CaO)	68.43	63.9
Sulfat oxide (SO_3)	3.2	2.53
Sodium + Potassium oxide Na_2O+K_2O	1.58	0.88
Magnessium oxide (MgO)	4.8	1.53
Loss on Ignition (LOI)	N/A	1.58

Analyzes using XRF are performed based on identification and enumeration of X-ray radiation occurring from the photoelectric effect event. The photoelectric effect occurs because the electrons in target atoms (samples) are hit by high-energy collisions (gamma radiation, X-rays). The guideline used in this test is ASTM C 114-07 [19] where the references are normative references which are considered highly relevant in the process of testing chemical compounds cement. Table 2 shows the chemical content of Portland cement according to ASTM C 114-07 [19]. The main forming ingredient of the new cement is, as shown by the testing result of concentrate chemical element in the Table 2, the CaO and the SiO_2, greater than 89.7% in total. Because of the abundance of C_3S, new hydraulic cement could be classified as alite type cement along with the belite, the tri calcium aluminate, and the brownmillerite.
Furthermore, the concentrate is tested using XRD. The X-ray diffraction test results are then analyzed by search and matching. From the results of the analysis, it has been observed that the chemical composition of cement indicates such similar

compound as existed in the Portland cement, of the same quantity. Of all the chemical elements present in the Portland cement, the most important chemical elements are Ca_3SiO_5 (Alite / C3S = Tricalcium Silicate), Ca_2 SiO_5 (Belite / C_2S = Dicalcium Silicate), $Ca_3Al_2O_6$ (Aluminate / C_3A = Tricalcium Aluminate), and $Ca_3Al_2FeO_{10}$ (Ferrite / C_4AF = Tetra Calcium Alumino Ferrite). In new cement, these four chemical elements have been obtained after combustion at high and controlled temperature between 1375 °C and 1400 °C. Figure 5 shows a comparison of XRD (X-Ray Difraction) analysis results between the new cement and Portland cement.

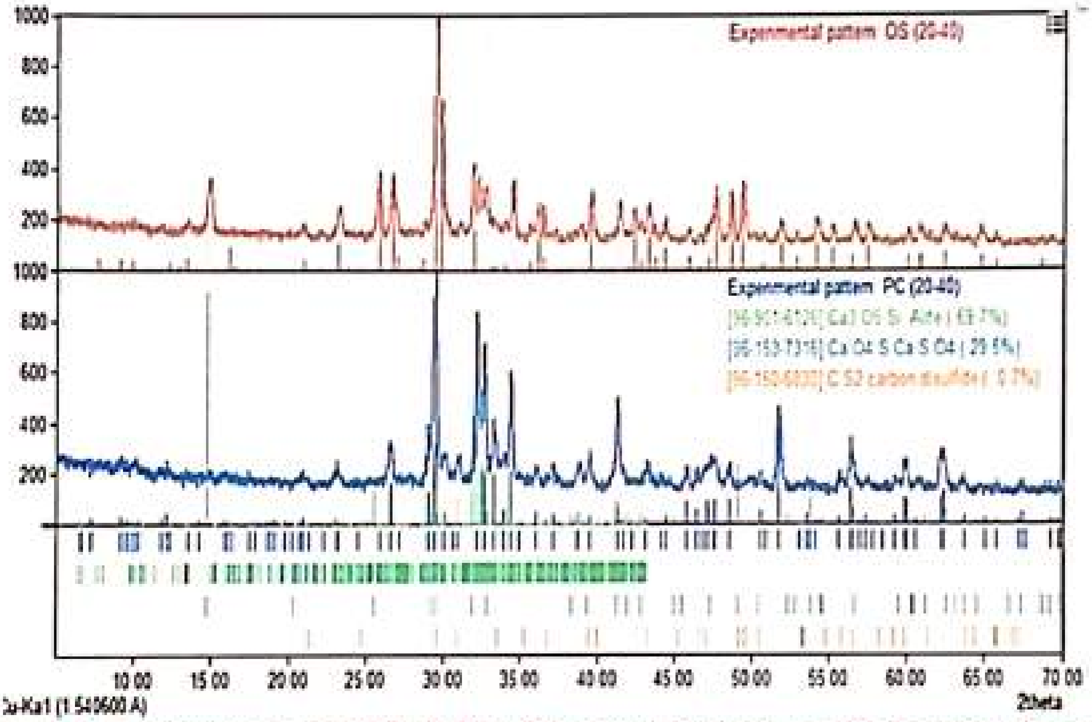

Figure 5. A comparison of XRD (X-Ray Difraction) analysis results between the new cement and Portland cement.

3.3 Physical properties

3.3.1 Fineness of new cement- sieve passing method and specific surface method

It is the total surface area of cement that makes material available for hydration because the hydration of cement-based material starts at the surface of the cement particle. Therefore, hydration depends on the fineness of the cement particle, and for a rapid development of strength such high fineness as in the current study is necessary. However, the cost of grinding and the effect of fineness on other properties, such as workability issues of fresh cement-based materials, long-term strength, and gypsum demand must be considered. Fineness is a significant property of cement, and is necessary to measure through the specific surface method (in m^2/kg) in regard to BS and ASTM standards. The specific surface of cement could be determined by the air permeability method, which measures the pressure drop when dry air flows at a constant velocity through a bed of cement of known porosity and thickness. Kumar and Nath (2020) reported their current study stood up for the finer particle provided better properties and microstructure for cement based materials in 2020 [30]. Kan et al. (2019) published a scientific study that mentioned the fineness activity property for cement-based bulk materials [31]. Table 4 gives the fineness of new cement and the Portland cement measured in the experimental study.

Table 4. The fineness of new cement and the Portland cement measured in the experimental study

Type of fineness measure	Type of material	
	New cement	Portland cement
200 (μm) sieve passing (%)	56	52
Specific Surface (kg/m³)	1200	1250

The fineness value for the new cement in the current study passes through the 200 mesh sieve by 56% with solid weight of 1200 (kg/m^3) while for the equivalent quantity for Portland cement is 52% with solid weight 1250 (kg/m^3). The smoother the cement, the surface of the granules will be greater so that the hydration with water will be faster and will have a large demand for water. Figure 6 shows a process of measuring the fineness and the density of new cement (A) and the Portland cement (B) that is used as a comparator in testing the physical properties.

(A) (B)

Figure 6. A process of measuring the fineness and the density of cement; new cement (A) and the Portland cement (B) that is used as a comparator in testing the physical properties.

In a cement-based mixture, the ratio of water to cement is defined as (water weight)/(cement weight) and often abbreviated as w/c. The w/c ratio has a strong influence on the strength of the concrete; For certain mixtures, increasing the ratio w/c will decrease strength at all ages, and lower the w/c ratio will increase the strength of the concrete [32]. Ghasemi et al. (2019) presented a current study examined a relationship between the specific surface of mortar constituent and the flow of mortar in 2019 [33]. This significant study reveals that the water demand of mortar depended on the surface area of the mixture ingredients; estimation of the specific surface area was improved by accounting for angularity; while water content and paste film thicknesses were vital for predicting the flowability [33].

3.3.2 Density of new cement

The adjustment of the bulk density in conjuction with compression and water reducer could ease workability of concrete as suspension [34]. Many studies which consider to optimize the final properties of concrete and cement based material have been carried out on the bulk density as well as a number of theoretical models developed to predict the bulk density of granular material [35–38]. The density of Portland cement is 3.15 (g/ml) while the density of the new cement is 3.05 (g/ml) as determined in the current experimental research. In this case, the density test refers to the ASTM C 188-95 [19] formulation. The result of physical characteristic test of the new cement in the form of density of fresh concrete unit is 2081 (kg/m³) with its dry weight of 2032 (kg/m³) which is lower than the fresh weight of concrete using Portland cement that is 2525 (kg/m³). Moreover, these models are related to the curve optimization of bulk density, compression of bulk density, and the quantity calculation. Firstly, selection of the concrete and cement-based material has to be started with the selection of side edge space of formwork for construction element so that the rust raito could be placed in the space. This selection needs the bulk density of concrete mixture used. Lastly, the bulk density model depends on the theoretical density of the concrete and cement based material mixture. This theoretical density could be calculated mathematically by measuring the bulk density of different mean size of the particle in the cement [36, 39].

3.3.3 Consistency and setting-time of new cement

The cement setting time is the starting process of a chemical compound reaction that occurs in cement just after the cement reacts with water so that the cement can become hard and withstand pressure. Table 5 presents the consistency of new cement and Portland cement, and the penetration depth and the water demand.

Table 5. Consistency properties of the new cement and of c Portland cement

Types of cement	Consistency (%)	Penetration depth (mm)	Water demand (g)
New cement	37	25	185
Portland cement	25	24	130

In this experimental research, the measured setting time of the new cement and the Portland cement is initial setting time and final setting time. The cement that has been mixed with water or the cement at a humid temperature causes a chemical reaction in the form of setting of cement particle. The time required by the cement during the setting process shortly after a chemical reaction with water or humid temperature causes the cement to harden, the reference used in this test is ASTM C 191-19 [25]. The initial and final setting times of the new cement and Portland cement were tested using a 1 mm diameter Vicat needle method for the Portland cement that penetrated the cement paste as deep as 24 (mm) in the 90 minute after the needle was removed. The water content used for the setting test of the Portland cement was 25% water content with normal consistency. The standard used for normal consistency is ASTM C 187-04 [24]. The initial setting time of new cement penetrating for the cement paste was 25 (mm) deep, after 105 minutes. The water content used for this initial setting test was the 37% water content with normal consistency. By

ASTM C 191-19 standard [25], initial setting time should not be less than 45 (min). The final setting time of Portland cement is at 180 (min), while for new cement is at 225 (min). The obtained time of setting results for both the new cement and the Portland cement comply with the ASTM C 191-19.
That the initial assembly process is slow for the new cement can be considered due to the finer grain size of portland cement as described in section 3.3.1 (fine). This causes the need for water in the binding process to require more than the binding process on portland cement which of course will have an impact on the final binding process on new cement compared to portland cement.

4. Conclusions

From the results of examination of fineness, density and chemical properties of the new cement, there is resemblance with Portland cement chemical compounds. This can be seen from the XRF (X-Ray Flourencence) and XRD (X-Ray Difraction) test results. The test results of physical properties of cement based on empirical studies approach the normative references on ASTM.
The fineness value of this new cement is finer than Portland cement with a solid weight of 1200 (kg/m3) lighter than Portland cement which reaches 1250 (kg/m3). The specific gravity of Portland cement is 3.15 (g/ml) while the density of new cement is 3.05 (g/ml). The initial setting time of portland cement was obtained 90 minutes where the vikat needle penetrated the cement paste for 24 mm after the needle was removed. The initial setting time of the new cement was also tested by the same method by penetrating 25 mm of cement for 105 minutes after the needle was removed. The final setting time of portland cement is 180 while the new cement reaches 225 minutes
Based on the results of the cement feasibility test, it can be assumed that the cement studied can be used for the work of installing plastering brick walls, floors and so on.
However, it is deemed necessary to conduct further experimental studies to ensure that the cement quality can be as expected based on the American Standard Testing And Material (ASTM) reference. So that in the end the problem of waste and efforts to save the environment from the accumulation of waste can be considered wisely through an experimental study approach as an alternative cement.

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Gmail Muhammad Syarif <muhsyarif00@gmail.com>

SEM/EDX images and conclusions of them for article JMRT-D-21-01643. (Quinary article).
3 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 25 Agustus 2021 06.46
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Andre Gustavo de Sousa Galdino <andre.galdino@ifes.edu.br>, "andregsg@ifes.edu.br" <andregsg@ifes.edu.br>, Muhammad Syarif <muhsyarif00@gmail.com>

Dear André and Syarif:

Thank you very much for your limitless supporting.

In the email attachment, there are SEM images, EDX analyzings, samples photo of Word file for Figure 4, and an analyzing/comparison/conclusion Word file for the article.

I whole-heartedly hope that it will be accepted very soon.

I am looking forward to hearing you and working with you collaboratively very much.

With my best regards and my best wishes,
Serkan

6 lampiran

4. PASTE ORGANIC CEMENT.jpeg
140K

5. PASTE PORTLAND CEMENT.jpeg
244K

Analyzing of SEM_EDX.docx
399K

1. Concrete Sampel.docx
774K

2. Concrete Potrland Cement.pdf
107K

3. Concrete Organic Cement.pdf
142K

Andre Gustavo de Sousa Galdino <andre.galdino@ifes.edu.br> 25 Agustus 2021 09.11
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>, Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

Dear Serkan and Syarif,

Thank you very much for your help!

Please, I need the .txt file from XRD to make a new diffractogram. JMRT reviewers told that we need to improve this figure.

I attached an example of .txt file from XRD diffractometer. There is other file, with the results and phases identification.

Thank you again!

My best wishes and my best regards,

André Gustavo de Sousa Galdino, D.Sc.
Professor EBTT
Coordenadoria de Mecânica

INSTITUTO FEDERAL
Espírito Santo
Campus Vitória

Instituto Federal do Espírito Santo – Campus Vitória
27 3331 2100 ramal 2160

De: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Enviado: quarta-feira, 25 de agosto de 2021 10:46
Para: Andre Gustavo de Sousa Galdino; Andre Gustavo de Sousa Galdino; Muhammad Syarif
Assunto: SEM/EDX images and conclusions of them for article JMRT-D-21-01643. (Quinary article).

[Kutipan teks disembunyikan]

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2 lampiran

Amostra_Branco_geral1.pdf
2263K

Amostra_Branco_geral1.txt
113K

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 25 Agustus 2021 09.14
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

Sent from Yahoo Mail on Android
[Kutipan teks disembunyikan]

2 lampiran

Amostra_Branco_geral1.pdf
2263K

Amostra_Branco_geral1.txt
113K

Gmail

Muhammad Syarif <muhsyarif00@gmail.com>

About XRD txt file.

1 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

25 Agustus 2021 09.28

Dear Friend:

Assalamualaikum wr. wb.

Please send your XRD txt file to Dear Dr. Galdino.

After that, I whole-heartedly hope that it will be published very soon.

I am looking forward to hearing you.

With my best regards and my best wishes,

Serkan

Sent from Yahoo Mail on Android

Gmail

Muhammad Syarif <muhsyarif00@gmail.com>

About txt file of XRD.

3 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 25 Agustus 2021 10.14
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

My Dear Friend:

Assalamualaikum wr. wb.

I whole-heartedly hope that you and your family are very well, and always stay healthy and happy and safe.

Please send the txt file of XRD to Dear Dr. Galdino immediately so that he could make the article develop before resubmission.

All right?

I am looking forward to hearing you and working with you collaboratively very much.

With my best regards and my best wishes,
Serkan

Sent from Yahoo Mail on Android

Muhammad Syarif <muhsyarif00@gmail.com> 25 Agustus 2021 16.38
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

My Dear Friend
Waalaikumsalam..Wr..WB

Here I send the XRD. Thank you

Best Regards

Muhammad Syarif

[Kutipan teks disembunyikan]

2 lampiran

OS (20-40)_Report.pdf
186K

PC (20-40)_Report.pdf
200K

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 25 Agustus 2021 17.49
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: muhsyarif00@gmail.com

Dear Friend Muhammad:

Assalamualaikum wr. wb.

I whole-heartedly hope that you and your family are very well, and always stay healthy and happy and safe.

I conveyed your XRD file to Dear Dr. Galdino immediately.

Thank you for limitless supporting. I whole-heartedly hope that the very interesting article will be published very soon.

I am looking forward to working with you collaboratively very much.

With my best wishes and my best regards,
Serkan

Sent from Yahoo Mail on Android

[Kutipan teks disembunyikan]

Match! Phase Analysis Report

Sample: OS (20-40)

Sample Data

File name	OS.RAW
File path	F:/SAMPEL BARU/OS
Data collected	Apr 25, 2018 17:04:14
Data range	5.000° - 70.000°
Number of points	3251
Step size	0.020
Rietveld refinement converged	No
Alpha2 subtracted	No
Background subtr.	No
Data smoothed	Yes
Radiation	X-rays
Wavelength	1.540600 Å

Matched Phases

Index	*Amount (%)*	*Name*	*Formula sum*
A	59.5	Calcite	C Ca O3
B	29.5	Bassanite	Ca3 H4 O13.8 S3
C	11.0	Silicon oxide $-alpha Quartz low	O2 Si
	2.3	*Unidentified peak area*	

A: Calcite (59.5 %)

Formula sum	C Ca O3
Entry number	96-901-6707
Figure-of-Merit (FoM)	0.882425
Total number of peaks	43
Peaks in range	18
Peaks matched	13
Intensity scale factor	0.98
Space group	R -3 c
Crystal system	trigonal (hexagonal axes)
Unit cell	a= 4.9844 Å c= 17.0376 Å
I/Ic	3.10
Calc. density	2.720 g/cm³
Reference	Ondrus P., Veselovsky F., Gabasova A., Hlousek J., Srein V., Vavrin I., Skala R., Sejkora J., Drabek M., "Primary minerals of the Jachymov ore district", Journal of the Czech Geological Society 48, 19-147 (2003)

B: Bassanite (29.5 %)

Formula sum	Ca3 H4 O13.8 S3
Entry number	96-901-2211
Figure-of-Merit (FoM)	0.833210
Total number of peaks	176
Peaks in range	132
Peaks matched	57
Intensity scale factor	0.22
Space group	I 1 2 1
Crystal system	monoclinic
Unit cell	a= 11.9845 Å b= 6.9292 Å c= 12.7505 Å γ= 90.000 °
I/Ic	1.37
Calc. density	2.766 g/cm³
Reference	Bezou C., Nonat A., Mutin J. C., Christensen A. N., Lehmann M. S., "Of the crystal structure of gamma-CaSO4, CaSO4*0.5(H2O), and CaSO4*0.6(H2O) by powder diffraction methodsLocality: Maurienne, FranceSample: SH2, X-ray diffraction", Journal of Solid State Chemistry 117, 165-176 (1995)

C: Silicon oxide $-alpha Quartz low (11.0 %)

Formula sum	O2 Si
Entry number	96-101-1173
Figure-of-Merit (FoM)	0.746822
Total number of peaks	35
Peaks in range	15
Peaks matched	8
Intensity scale factor	0.27
Space group	P 31 2 1
Crystal system	trigonal (hexagonal axes)
Unit cell	a= 4.9130 Å c= 5.4050 Å
I/Ic	4.83
Meas. density	2.660 g/cm³
Calc. density	2.649 g/cm³
Reference	Brill R, Hermann C, Peters C, "Studien ueber chemische Bindung mittels Fourieranalyse III. Die Bindung im Quarz", Naturwissenschaften 27, 676-677 (1939)

Candidates

Name	*Formula*	*Entry No.*	*FoM*
(Hg Pt3)0.5	Hg0.5 Pt1.5	96-153-9505	0.7738
	Al K O2	96-210-5209	0.7716
(Mg0.25 Tb0.75)	Mg0.25 Tb0.75	96-152-2525	0.7682
Pd Zn	Pd Zn	96-153-8776	0.7526
Zr H2	H2 Zr	96-154-0310	0.7409
Ce Zn0.82 Sb2	Ce Sb2 Zn0.82	96-153-3079	0.7401
Zr H2	H2 Zr	96-231-0941	0.7388
Si3 N4	N4 Si3	96-153-4044	0.7354

Siderite	C Fe O3	96-901-6600	0.7350
Siderite	C Fe O3	96-901-4238	0.7313
Sc P	P Sc	96-231-0239	0.7256
Thallium	Tl	96-900-8520	0.7233
Ce Zn0.81 Sb2	Ce Sb2 Zn0.81	96-153-3077	0.7219
Pt O	O Pt	96-412-4670	0.7214
tricalcium oxynitride silicate	Ca2.894 N1.76 O4.24 Si2	96-223-2240	0.7207
Cu Se	Cu Se	96-210-6770	0.7198
Tl	Tl	96-154-0305	0.7197
Ni Ti2	Ni Ti2	96-152-7849	0.7164
Mo3 Si	Mo3 Si	96-153-8542	0.7158
Ag Eu P	Ag Eu P	96-720-9335	0.7143
Zr H2	H2 Zr	96-403-1668	0.7139
Siderite	C Fe O3	96-901-4762	0.7135
Ti4 Fe2 O0.4	Fe2 O0.4 Ti4	96-153-0663	0.7131
Helium	He	96-901-1633	0.7108
Na Cr S2	Cr Na S2	96-153-6538	0.7102
(Mg Al2 Si3 O10).6	Al1.2 Mg0.6 O6 Si1.8	96-810-4271	0.7099
Y (Si Zn)	Si Y Zn	96-152-7634	0.7094
dilanthanum-diiron-monoiodide	Fe2 I La2	96-810-0731	0.7089
Ni2 Ti4 O	Ni2 O Ti4	96-152-7850	0.7088
Mn S	Mn S	96-153-6621	0.7086
	Cu1.8 Se	96-210-2501	0.7083
Er In	Er In	96-231-0307	0.7065
Mo3 Si	Mo3 Si	96-153-8779	0.7057
Mo5 B2 Si	B2 Mo5 Si	96-151-0769	0.7051
Er (In2 Sn)	Er In2 Sn	96-152-4238	0.7051
Mo3 Si	Mo3 Si	96-153-9177	0.7051
Ce Cu Sn	Ce Cu Sn	96-152-8233	0.7049
Y2.667 Se4	Se4 Y2.667	96-434-4326	0.7043
(Ag2 Al)0.66	Ag1.334 Al0.666	96-150-9590	0.7042
(Sc Y) S2	S2 Sc Y	96-152-8089	0.7036
	Li Nb O3	96-210-1178	0.7027
(Co0.2 Ni0.8)2 Gd	Co0.4 Gd Ni1.6	96-152-4903	0.7020
Dy Tl	Dy Tl	96-231-0277	0.7016
Sr.7 La.3 Ti O3	La0.3 O3 Sr0.7 Ti	96-153-8294	0.7012
In O (O H)	H In O2	96-152-7724	0.7005
Mo V	Mo V	96-153-9023	0.7005
carbon disulfide	C S2	96-150-6831	0.7004
(Cu0.25 Ga0.75)2 Y	Cu0.5 Ga1.5 Y	96-152-4859	0.7001
Pb U	Pb U	96-231-0900	0.6999
	Ag La	96-900-8799	0.6999
Sn0.74 (O0.96 (O H)1.04)	H1.04 O2 Sn0.74	96-153-3665	0.6994
	Au5 Zn8	96-591-0023	0.6987

and 150 others...

Search-Match

Settings

Reference database used	COD-Inorg REV189751 2017.01.03
Automatic zeropoint adaptation	Yes
Minimum figure-of-merit (FoM)	0.60
2theta window for peak corr.	0.30 deg.
Minimum rel. int. for peak corr.	1
Parameter/influence 2theta	0.50
Parameter/influence intensities	0.50
Parameter multiple/single phase(s)	0.50

Criteria for entries added by user

Reference:

Entry number:

96-100-0045;96-101-1095;96-101-1096;96-101-1328;96-900-6695;96-900-6696;96-900-6697;96-900-6698;96-900-6699;96-900-6700;96-900-6701;96-900-6702;96-900-6703;96-900-6704;96-900-6705;96-900-6705;96-900-6707;96-900-6708;96-900-6709;96-900-6710;96-900-6711;96-900-6712;96-900-6713;96-900-6714;96-900-6715;96-900-6716;96-900-6717;96-900-6718;96-900-6719;96-900-6720;96-900-6721;96-900-6722;96-900-6723;96-900-6724;96-900-6725;96-900-6726;96-900-6727;96-900-6728;96-900-6729;96-900-6730;96-900-6731;96-900-6732;96-900-6733;96-900-6734;96-900-6735;96-900-6736;96-900-6737;96-900-6738;96-900-6739;96-900-6740;96-900-6741;96-900-6742;96-900-6743;96-900-6744;96-900-6745;96-900-6746;96-900-6747;96-900-8606

Peak List

No.	*2theta [°]*	*d [Å]*	*I/I0*	*FWHM*	*Matched*
1	9.88	8.9453	22.31	1.1516	B
2	11.70	7.5576	23.73	0.2102	
3	13.44	6.5826	43.45	0.4720	
4	14.84	5.9648	263.76	0.3607	B
5	20.84	4.2590	59.45	0.3875	B,C
6	23.20	3.8309	147.39	0.3627	A,B
7	25.72	3.4609	314.46	0.2719	B
8	26.66	3.3410	266.24	0.3874	C
9	29.50	3.0255	1000.00	0.4626	A,B
10	29.82	2.9938	161.51	0.1512	B
11	31.00	2.8824	57.79	0.2800	
12	31.86	2.8066	194.01	1.3084	B
13	32.26	2.7727	65.39	0.9185	
14	32.66	2.7396	139.64	0.1831	
15	33.92	2.6407	43.76	1.8679	
16	34.46	2.6005	224.18	0.1616	B
17	36.04	2.4901	104.83	0.5499	A,B

18	37.22	2.4138	38.26	0.1606	
19	38.88	2.3145	68.31	0.3700	B
20	39.50	2.2796	227.34	0.2589	A,B,C
21	41.32	2.1833	149.95	0.3674	B
22	42.34	2.1330	70.41	1.6303	B,C
23	43.30	2.0879	125.53	0.2493	A,B
24	44.32	2.0422	79.97	0.2294	B
25	45.90	1.9755	38.99	0.1551	C
26	47.62	1.9081	219.45	0.4120	A,B
27	48.56	1.8733	212.96	0.3020	A,B
28	49.36	1.8448	281.77	0.2507	B
29	51.80	1.7635	95.20	0.2971	
30	52.90	1.7294	35.66	0.2641	B
31	54.24	1.6898	105.82	0.3682	B
32	55.18	1.6632	79.85	0.2217	B,C
33	56.60	1.6248	76.56	0.4688	A
34	57.56	1.6000	82.01	0.3119	A,B
35	58.74	1.5706	13.46	0.2999	B
36	60.16	1.5369	47.01	0.3583	B,C
37	60.78	1.5227	66.28	0.4518	A,B
38	62.44	1.4861	70.63	0.4729	B
39	64.80	1.4376	60.12	0.3612	A
40	65.74	1.4193	36.91	0.2493	A,B,C

Rietveld Refinement using FullProf

Calculation was not run or did not converge.

Crystallite Size Estimation using Scherrer Formula

Calculation was not run.

Integrated Profile Areas

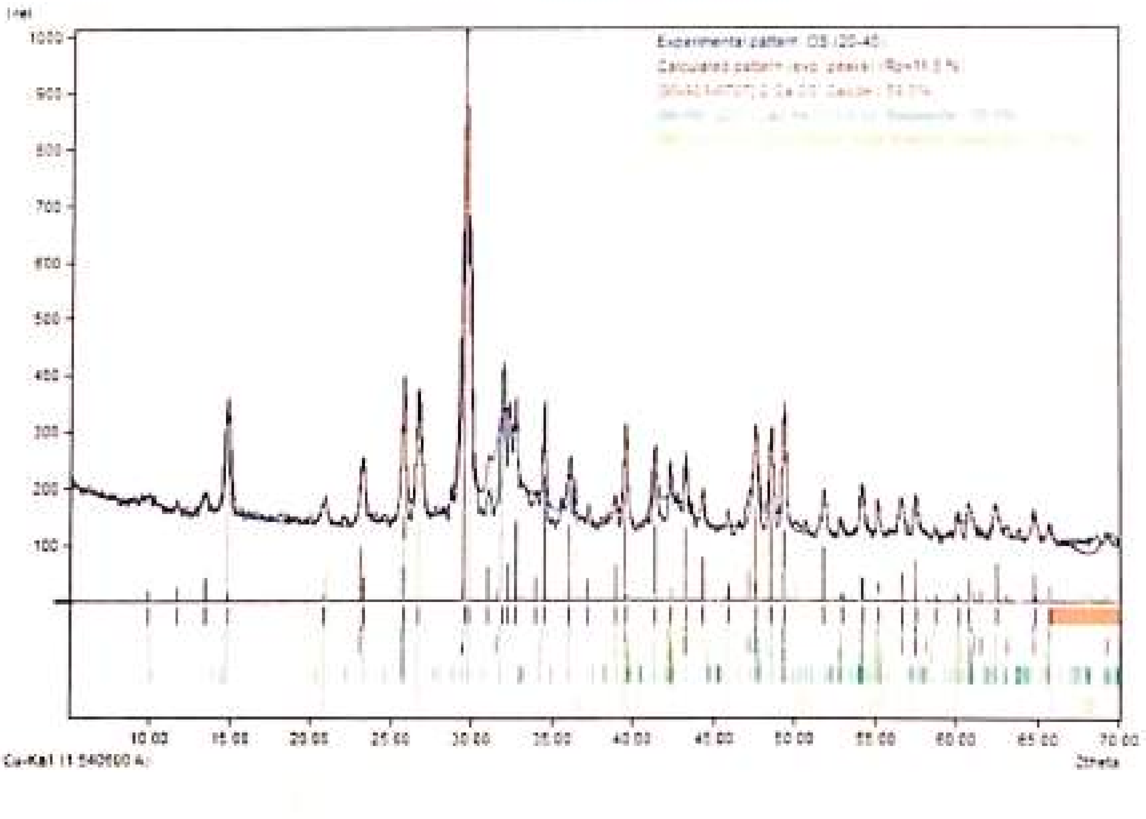
Based on calculated profile

Profile area	*Counts*	*Amount*
Overall diffraction profile	933329	100.00%
Background radiation	751936	80.56%
Diffraction peaks	181393	19.44%
Peak area belonging to selected phases	306847	32.88%
Peak area of phase A (Calcite)	143745	15.40%
Peak area of phase B (Bassanite)	123045	13.18%
Peak area of phase C (Silicon oxide $-alpha Quartz low)	40057	4.29%
Unidentified peak area	30978	3.32%

Peak Residuals

Peak data	*Counts*	*Amount*
Overall peak intensity	4026	100.00%
Peak intensity belonging to selected phases	889	22.08%
Unidentified peak intensity	3137	77.92%

Diffraction Pattern Graphics



Match! Phase Analysis Report

Sample: PC (20-40)

Sample Data

File name	PC.RAW
File path	F:/sAMPEL BARU/PC
Data collected	Apr 25, 2018 17:04:13
Data range	5.000° - 70.000°
Number of points	3251
Step size	0.020
Rietveld refinement converged	No
Alpha2 subtracted	No
Background subtr.	No
Data smoothed	Yes
Radiation	X-rays
Wavelength	1.540600 Å

Matched Phases

Index	*Amount (%)*	*Name*	*Formula sum*
A	70.8	Alite	Ca3 O5 Si
B	12.1	Calcium cyclo-hexaaluminate	Al6 Ca9 O18
C	10.0	Calcite	C Ca O3
D	7.1	Lime	Ca O
	2.3	*Unidentified peak area*	

A: Alite (70.8 %)

Formula sum	Ca3 O5 Si
Entry number	96-901-6126
Figure-of-Merit (FoM)	0.833805
Total number of peaks	499
Peaks in range	499
Peaks matched	154
Intensity scale factor	0.63
Space group	P -1
Crystal system	triclinic (anorthic)
Unit cell	a= 11.6389 Å b= 14.1716 Å c= 13.6434 Å α= 104.982° β= 94.622 ° γ= 90.107 °
I/Ic	0.79
Calc. density	3.149 g/cm³
Reference	De la Torre A. G., De Vera R. N., Cuberos A. J. M., Aranda M. A. G., "Crystal structure of low magnesium-content alite application to Rietveld quantitative phase analysis", Cement and Concrete Research **38**, 1261-1269 (2008)

B: Calcium cyclo-hexaaluminate (12.1 %)

Formula sum	Al6 Ca9 O18
Entry number	96-100-0040
Figure-of-Merit (FoM)	0.788212
Total number of peaks	147
Peaks in range	99
Peaks matched	37
Intensity scale factor	0.46
Space group	P a -3
Crystal system	cubic
Unit cell	a= 15.2630 Å
I/Ic	3.39
Meas. density	3.020 g/cm³
Calc. density	3.028 g/cm³
Reference	Mondal P, Jeffery J W, "The crystal structure of tricalcium aluminate, Ca~3~ Al~2~ O~6~", Acta Crystallographica B (24,1968-38,1982) **31**, 689-697 (1975)

C: Calcite (10.0 %)

Formula sum	C Ca O3
Entry number	96-901-6707
Figure-of-Merit (FoM)	0.832959
Total number of peaks	43
Peaks in range	18
Peaks matched	13
Intensity scale factor	0.35
Space group	R -3 c
Crystal system	trigonal (hexagonal axes)
Unit cell	a= 4.9844 Å c= 17.0376 Å
I/Ic	3.10
Calc. density	2.720 g/cm³
Reference	Ondrus P., Veselovsky F., Gabasova A., Hlousek J., Srein V., Vavrin I., Skala R., Sejkora J., Drabek M., "Primary minerals of the Jachymov ore district", Journal of the Czech Geological Society **48**, 19-147 (2003)

D: Lime (7.1 %)

Formula sum	Ca O
Entry number	96-900-6743
Figure-of-Merit (FoM)	0.775290
Total number of peaks	14
Peaks in range	5
Peaks matched	4
Intensity scale factor	0.39
Space group	F m -3 m
Crystal system	cubic

Unit cell	a= 4.9870 Å
I/Ic	4.90
Calc. density	3.003 g/cm³
Reference	Fiquet G., Richet P., Montagnac G., "High-temperature thermal expansion of lime, periclase,corundum and spinelSample: Re wire, T = 2573 K". Physics and Chemistry of Minerals **27**, 103-111 (1999)

Candidates

Name	*Formula*	*Entry No.*	*FoM*
	Ni Ti0.876	96-900-9985	0.7722
	Ni Ti0.875	96-900-9984	0.7721
	Ni Ti0.88	96-900-9983	0.7720
Dilithium Oxide	Li2 O	96-151-4098	0.7641
Gadolinium	Gd	96-900-8500	0.7622
Gadolinium	Gd	96-901-0992	0.7622
Ce Cu Sn	Ce Cu Sn	96-152-8233	0.7548
Ag La Ge	Ag Ge La	96-150-9370	0.7529
	Al K O2	96-210-5208	0.7445
	Al K O2	96-210-5209	0.7429
Tristrontium cyclo-hexaaluminate	Al6 O18 Sr9	96-100-8451	0.7414
	Al2 O6 Sr3	96-901-5879	0.7414
	N2 O4 Si2 Sr3	96-432-8643	0.7407
	Al2 O6 Sr3	96-200-0992	0.7404
Bi2 Gd O4 Br	Bi2 Br Gd O4	96-152-6517	0.7401
Gd0.8 Pr0.2	Gd0.8 Pr0.2	96-152-3783	0.7397
Bi2 Eu O4 Br	Bi2 Br Eu O4	96-152-6515	0.7395
Bi2 Sm O4 Br	Bi2 Br O4 Sm	96-152-6513	0.7393
Cs Sm21 (Se O3)24 Br16	Br16 Cs O72 Se24 Sm21	96-153-7243	0.7390
Gd0.8 Nd0.2	Gd0.8 Nd0.2	96-152-2980	0.7388
arsenolite	As4 O6	96-451-3582	0.7378
Y	Y	96-153-9819	0.7357
(Dy La)	Dy La	96-152-4763	0.7343
Gd Y	Gd Y	96-152-2937	0.7339
(Ce0.2 Gd0.8)	Ce0.2 Gd0.8	96-152-4490	0.7331
(Hg Pt3)0.5	Hg0.5 Pt1.5	96-153-9505	0.7314
Mn Te	Mn Te	96-153-8875	0.7308
Ag Cd	Ag Cd	96-150-9176	0.7303
(Mg0.25 Tb0.75)	Mg0.25 Tb0.75	96-152-2525	0.7303
	Al Ca Si	96-210-0610	0.7289
La (Ba1.3 La0.7) Cu3 O7.3	Ba1.3 Cu3 La1.7 O7.3	96-152-5804	0.7285
(Sn0.215 Tl0.785)	Sn0.215 Tl0.785	96-152-8102	0.7283
dilanthanum-diiron-monoiodide	Fe2 I La2	96-810-0731	0.7281
	Ba0.41 Ca0.39 Fe1.25 Nd0.45 O3.25	96-410-7911	0.7278
Cu6.2 P S5 Cl	Cl Cu6.2 P S5	96-810-4052	0.7269
	Ba1.62 Ca1.56 Fe5 Nd1.82 O13	96-410-7910	0.7253
Lanthanum barium copper oxide (1.5/1.5/3/7.02)	Ba1.5 Cu3 La1.5 O7.02	96-100-1377	0.7244
(Ba1.5 La0.5) La Cu3 O7.035	Ba1.5 Cu3 La1.5 O7.035	96-152-1462	0.7227
Danalite	Be3 Fe4 O12 S Si3	96-900-4818	0.7225
La (Pb0.5 Tl0.5)3	La Pb1.5 Tl1.5	96-152-3801	0.7223
Disodium cerium(IV) oxide	Ce2.67 Na5.34 O8.01	96-101-0653	0.7221
Ag1.1 Hg0.9	Ag1.1 Hg0.9	96-150-9580	0.7219
Sr2LaFe3O8	Fe3 La O8 Sr2	96-154-4359	0.7214
Danalite	Be3 Fe4 O12 S Si3	96-900-4817	0.7214
(Nd0.33 Sr0.67) (Ru0.33 Cu0.67) O3	Cu0.67 Nd0.33 O3 Ru0.33 Sr0.67	96-153-2198	0.7213
Er N	Er N	96-152-7647	0.7199
La Ba2.6 Cu3.3 O8.2	Ba2.6 Cu3.3 La O8.2	96-153-9444	0.7195
Gadolinium	Gd	96-900-8499	0.7192
Minium	O4 Pb3	96-901-2125	0.7187
Ga3 Y5	Ga3 Y5	96-152-8256	0.7186
	Ag Nb O3	96-201-1199	0.7186
Asisite	Cl O4 Pb3.5	96-900-1144	0.7184

and 150 others...

Search-Match

Settings

Reference database used	COD-Inorg REV189751 2017.01.03
Automatic zeropoint adaptation	Yes
Minimum figure-of-merit (FoM)	0.60
2theta window for peak corr.	0.30 deg.
Minimum rel. int. for peak corr.	1
Parameter/influence 2theta	0.50
Parameter/influence intensities	0.50
Parameter multiple/single phase(s)	0.50

Peak List

No.	*2theta [°]*	*d [Å]*	*I/I0*	*FWHM*	*Matched*
1	9.18	9.6257	90.88	0.2000	
2	9.88	8.9453	68.19	1.1800	A,B
3	11.78	7.5064	47.69	0.5104	
4	12.32	7.1786	41.40	0.8699	A
5	15.88	5.5764	44.33	0.5793	A
6	20.84	4.2590	79.58	0.6688	A,B
7	23.04	3.8571	144.98	0.4563	A,B,C
8	26.50	3.3608	356.88	0.3122	A,B
9	29.58	3.0175	1000.00	0.7943	A,C
10	30.06	2.9704	269.33	0.4000	A,B
11	31.00	2.8824	193.97	0.2160	A,D

12	32.18	2.7794	980.75	0.7320	A,B
13	32.66	2.7396	747.44	0.1857	A
14	33.20	2.6963	451.42	0.2960	A,B
15	34.30	2.6123	876.06	0.3251	A
16	36.04	2.4901	153.42	0.2637	A,B,C,D
17	37.14	2.4188	132.28	0.6054	A,B
18	38.80	2.3191	202.60	0.4000	A
19	39.50	2.2796	257.07	0.3275	A,B,C
20	41.40	2.1792	523.78	0.5356	A,B
21	43.30	2.0879	148.44	0.8031	A,B,C
22	44.16	2.0492	72.64	0.2695	B
23	45.82	1.9788	170.57	0.2598	B
24	46.44	1.9538	156.29	0.2400	B
25	47.54	1.9111	227.50	1.1405	B,C
26	48.56	1.8733	154.43	0.1767	B,C
27	49.98	1.8234	86.33	0.4800	B
28	50.62	1.8018	88.53	0.3177	B
29	51.80	1.7635	738.97	0.2000	B,D
30	53.70	1.7055	45.02	1.2072	B
31	55.74	1.6478	121.95	1.8400	B
32	56.44	1.6290	333.70	0.2717	B,C
33	57.56	1.6000	65.29	0.3282	B,C
34	58.66	1.5726	50.31	0.1600	B
35	59.36	1.5557	90.42	0.3600	B
36	59.82	1.5425	241.71	0.3300	
37	60.78	1.5227	83.80	0.4265	B,C
38	62.28	1.4896	362.24	0.4142	B
39	63.70	1.4597	98.85	0.3644	B
40	64.72	1.4392	77.15	0.2800	B,C,D
41	65.82	1.4178	57.37	1.2400	B,C
42	67.56	1.3854	0.00	0.0344	
43	67.58	1.3854	0.00	0.0344	

Rietveld Refinement using FullProf

Calculation was not run or did not converge.

Crystallite Size Estimation using Scherrer Formula

Calculation was not run.

Integrated Profile Areas

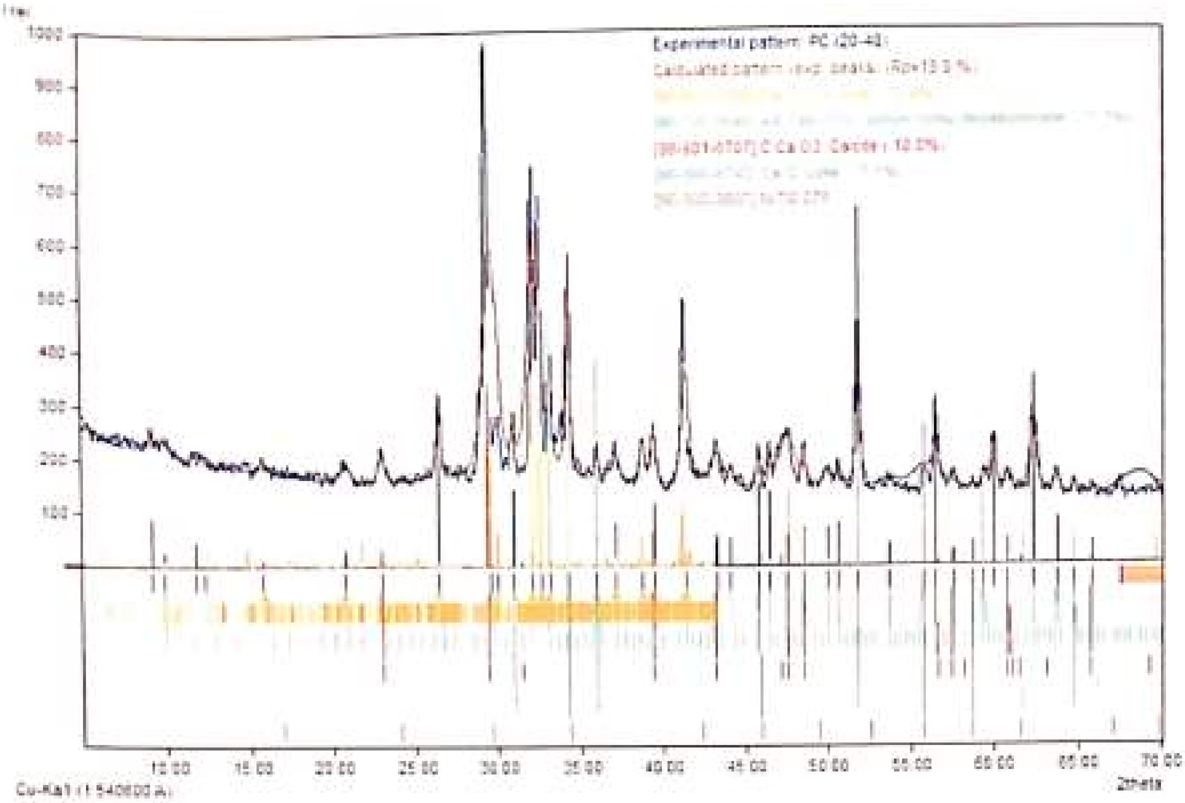
Based on calculated profile

Profile area	*Counts*	*Amount*
Overall diffraction profile	867936	100.00%
Background radiation	711873	82.02%
Diffraction peaks	156063	17.98%
Peak area belonging to selected phases	365000	42.05%
Peak area of phase A (Alite)	*222567*	*25.64%*
Peak area of phase B (Calcium cyclo-hexaaluminate)	*64756*	*7.46%*
Peak area of phase C (Calcite)	*42183*	*4.86%*
Peak area of phase D (Lime)	*35499*	*4.09%*
Unidentified peak area	19774	2.28%

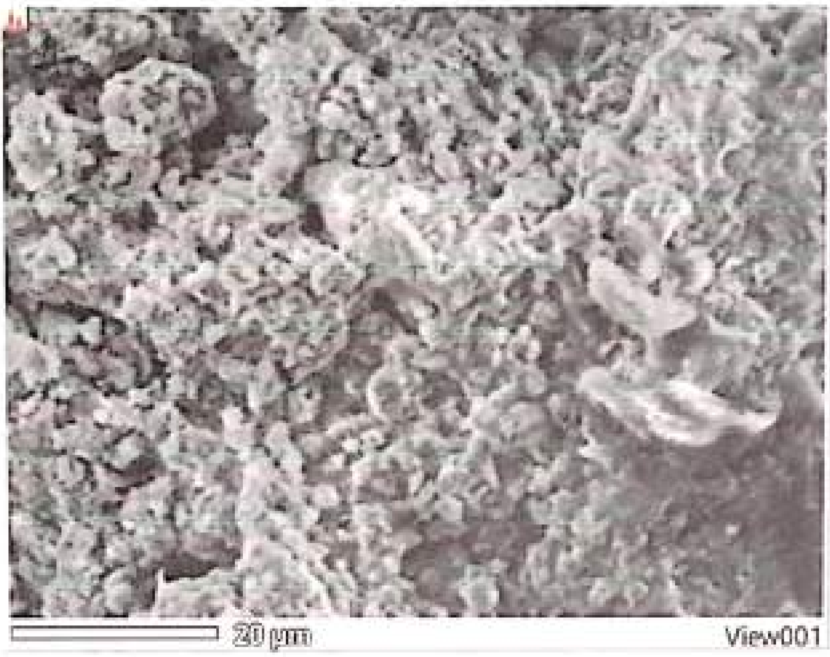
Peak Residuals

Peak data	*Counts*	*Amount*
Overall peak intensity	3643	100.00%
Peak intensity belonging to selected phases	-1831	-50.30%
Unidentified peak intensity	5475	150.30%

Diffraction Pattern Graphics

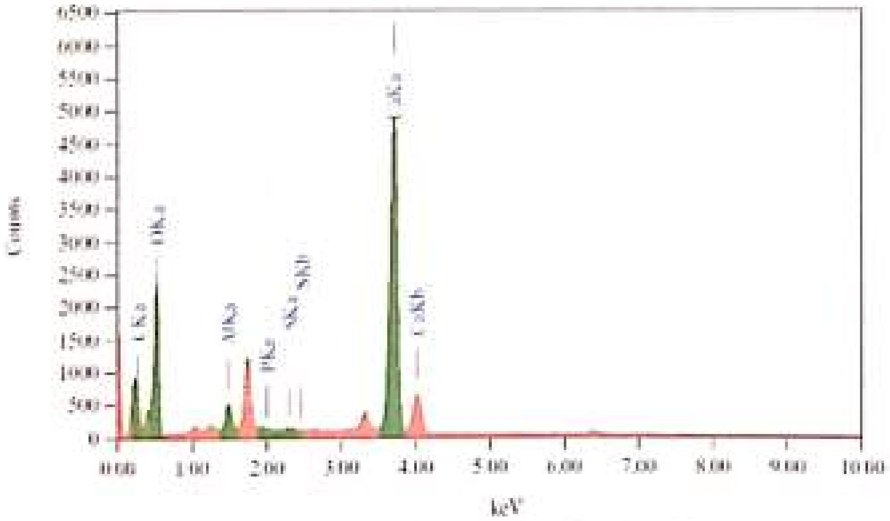

Experimental pattern: PC (20-40)
[96-901-0707] C Ca O3 Calcite (10.0%)
1000
900
800
700
600
500
400
300
200
100
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
2theta
Cu-Ka1 (1.540600 A)

Concrete Organic Cement



JEOL 1/1

Title	: IMG1
Instrument	: JCM-6000PLUS
Volt	: 15.00 kV
Mag.	: x 1,500
Date	: 2021/08/25
Pixel	: 512 x 384



Acquisition Parameter
Instrument : [illegible]
Acc. Voltage : [illegible]
Probe Current : [illegible]
PHA mode : [illegible]
Real Time : [illegible]
Live Time : [illegible]
Dead Time : [illegible]
Counting Rate : [illegible]
Energy Range : [illegible]

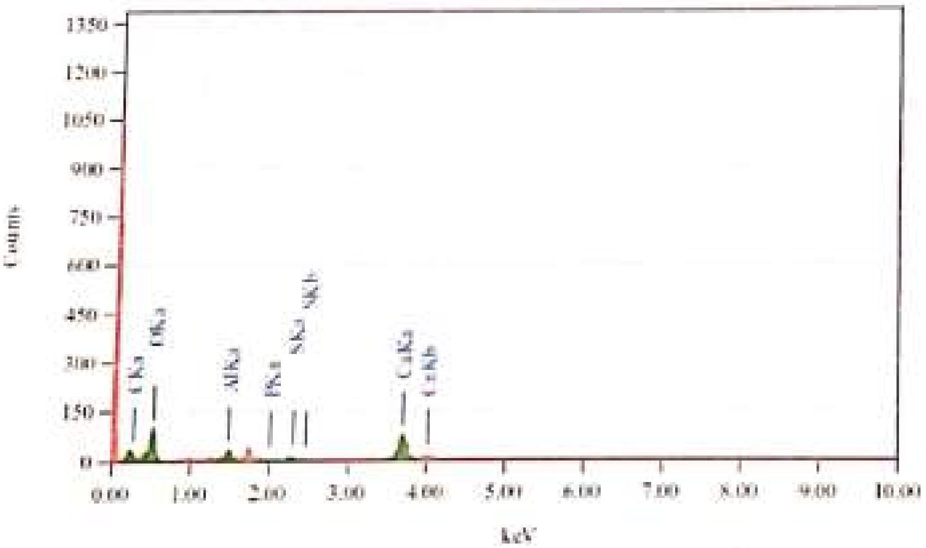
Thin Film Standardless Standardless Quantitative Analysis(Oxide)
Fitting Coefficient : 0.2596
Total Oxide : [illegible]

Element	(keV)	Mass%	Counts	Sigma	Mol%	Compound	Mass%	Cation	K
C K	0.277	1.67	477.22	1.44	7.44	C	1.67	0.00	1.8764
O		22.78					NI		
Al K	1.486	2.18	2838.46	0.13	1.19	Al2O3	4.11	1.07	0.5732
P K	2.013	0.17	187.13	0.07	0.15	P2O5	0.39	0.07	2.7852
S K	2.307	0.13	138.50	0.06	0.12	SO3	0.34	0.05	2.7415
Ca K (Ref.)	3.690	73.22	33568.45	0.82	91.10	CaO	93.49	22.04	1.0000
Total		100.00			100.00		100.00	23.24	

Concrete Portland Cement

JEOL 1/1

Title	:	IMG1
Instrument	:	JCM-6000PLUS
Volt	:	10.00 kV
Mag.	:	x 1,500
Date	:	2021/08/25
Pixel	:	512 x 384



Acquisition Parameter
Instrument : JCM-6000PLUS
Acc. Voltage : 10.0 kV
Probe Current : [illegible] nA
PHA mode : [illegible]
Real Time : [illegible] sec
Live Time : [illegible] sec
Dead Time : [illegible]
Counting Rate : [illegible] cps
Energy Range : 0 - 20 keV

Thin Film Standardless Standardless Quantitative Analysis(Oxide)
Fitting Coefficient : 0.[illegible]
Total Oxide : [illegible]

Element	(keV)	Mass%	Counts	Sigma	Mol%	Compound	Mass%	Cation	K
C K	0.277	[illegible]	9.67	0.28	[illegible]	C	1.11	0.00	[illegible]
O		[illegible]					ND		
Al K	1.486	[illegible]	[illegible]	[illegible]	[illegible]	Al2O3	[illegible]	[illegible]	[illegible]
P K	2.013	[illegible]	[illegible]	[illegible]	[illegible]	P2O5	[illegible]	[illegible]	[illegible]
S K	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SO3	[illegible]	[illegible]	[illegible]
Ca K (Ref.)	[illegible]	[illegible]	[illegible]	4.39	[illegible]	CaO	[illegible]	[illegible]	1.0000
Total		100.00			100.00		100.00	[illegible]	

Gmail

Muhammad Syarif <muhsyarif00@gmail.com>

Fw: Enc: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R2

7 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 11 September 2021 11.22
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Andre Gustavo de Sousa Galdino <andre.galdino@ifes.edu.br>, "andregsg@ifes.edu.br" <andregsg@ifes.edu.br>, Muhammad Syarif <muhsyarif00@gmail.com>

Hi Dear Andre:

As you, Dear Andre and Dear Syarif, could see the web link below, the Elsevier Language Editing Service works very expensive, $95 per 500 words for standard edition.

https://webshop.elsevier.com/language-editing-services/standard-edition/

As we have 9618 words in the article, the fee raises approximately $900. It is very huge price.

I think that we should ask our department of foreign language (especially American English language department) at our universities. Which one gives us a cheap service for language editing, we should be done this job to the department.

Okay?

I am looking forward to hearing you.

With my best regards and my best wishes,
Serkan

PS: Did you understand what the Editor's comments mean? For example,

" Page 2, Abstract, lines 2/3: "...and NC as well as X-ray diffraction (XRD) analysis of NC..."

He would like to say that we must add "as well as" in the above sentence in Abstract. This is what he says. Right?

----- Forwarded Message -----
From: Andre Gustavo de Sousa Galdino <andre.galdino@ifes.edu.br>
To: nakres42@yahoo.com <nakres42@yahoo.com>
Sent: Saturday, September 11, 2021, 08:14:01 PM GMT+3
Subject: Enc: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R2

Hi, Serkan!

We need to review it again, but this time is about English corrections. I think Elsevier Language Editing Service is paid (actually, I have never used this service).

What do you think?

My best regards and my best wishes,

André Gustavo de Sousa Galdino, D.Sc.
Professor EBTT
Coordenadoria de Mecânica
Instituto Federal do Espírito Santo – Campus Vitória
27 3331 2100 ramal 2160

De: em.jmrt.0.75ea64.2d4e11a3@editorialmanager.com <em.jmrt.0.75ea64.2d4e11a3@editorialmanager.com> em nome de Journal of Materials Research and Technology <em@editorialmanager.com>
Enviado: sexta-feira, 10 de setembro de 2021 21:46
Para: Andre Gustavo de Sousa Galdino

Assunto: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R2

Manuscript Number: JMRT-D-21-01643R2

Development and assessment of cement and concrete made of the burning of quinary by-product

Dear Dr. Galdino,

Thank you for resubmitting your manuscript to Journal of Materials Research and Technology.

I have completed my evaluation of your manuscript. The reviewers recommend its acceptance. I invite you to resubmit your manuscript after complete English corrections with the assistance of the Elsevier Language Editing Service and addressing my comments listed below up to page 3, with few examples of these corrections. Please, provide a thorough revision in the remaining pages and resubmit your revised manuscript by Sep 22, 2021.

When revising your manuscript, please consider all issues mentioned in my comments carefully: please outline every change made in response to my comments and provide suitable rebuttals for any comments not addressed. Please note that your revised submission may need to be re-reviewed.

To submit your revised manuscript, please log in as an author at https://www.editorialmanager.com/jmrt/, and navigate to the "Submissions Needing Revision" folder under the Author Main Menu.

Journal of Materials Research and Technology values your contribution and I look forward to receiving your revised manuscript.

Kind regards,

Prof. Sergio Neves Monteiro, PhD

Coeditor

Journal of Materials Research and Technology

Editor and Reviewer comments:

Editor:

- Page 2, Abstract, lines 2/3: "...and NC as well as X-ray diffraction (XRD) analysis of NC..."
- Page 2, Abstract, line 3/4: "...consistency, setting time of NC paste and slump, in addition to compressive strength (CS) and..."
- Page 2, Abstract, lines 5/6: "...suitable to make NC binder. The NC contains..."
- Page 3, lines 1/2: "...is 56%, while.....(PC) is 52%. The density of PC fulfils 96%..."
- Page 3, line 3: "...consistency. The initial and final....respectively 105 and 225 min, which is more than that of PC, 15 and 45 min, respectively." Please, do not repeat units in a sequence of values.
- Page 3, lines 6/7: "...Although the CS and STS of NCC are the lowest, velocities of the CS and STS are greater than..."
- Page 3, 1. Introduction, lines 14/15: "...the income, which is between US$ 20 and 45 per ton..."
- Page 3, 1. Introduction, lines 15/16: "...To the European Union (EU)....in 2011 for construction and demolition wastes (CDW),..."
- Page 3, 1. Introduction, line 17: "...in the EU annually,..."

Please, provide a thorough revision in the whole text and highlight all modifications. Thank you.

Reviewer #3: The authors made all requested corrections.

More information and support

FAQ: How do I revise my submission in Editorial Manager?

https://service.elsevier.com/app/answers/detail/a_id/28463/supporthub/publishing/

You will find information relevant for you as an author on Elsevier's Author Hub: https://www.elsevier.com/authors

FAQ: How can I reset a forgotten password?
https://service.elsevier.com/app/answers/detail/a_id/28452/supporthub/publishing/
For further assistance, please visit our customer service site: https://service.elsevier.com/app/home/supporthub/publishing/
Here you can search for solutions on a range of topics, find answers to frequently asked questions, and learn more about Editorial Manager via interactive tutorials. You can also talk 24/7 to our customer support team by phone and 24/7 by live chat and email

---

Revision_Due.ics
1K

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 11 September 2021 11.29
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

Dear Dr. Syarif:

Assalamualaikum wr. wb.

Congratulations! All we need is a Language Editing Service for new cement article which will be accepted by reviewers. The Editor suggested us to make the article correct in terms of English grammar. So, it will be published very soon in the JMR&T.

I guess that we will achieve this job very soon and we will inform you very soon.

Thank you in advance.

I am looking forward to hearing you and working with you collaboratively very much.

With my best regards and my best wishes,
M. Serkan KIRGIZ, Ph.D., M.Sc., B.Sc., P.C.T.
Professor of Materials
Chair

Nişantaşı University

[Kutipan teks disembunyikan]

Revision_Due.ics
1K

Muhammad Syarif <muhsyarif00@gmail.com> 28 September 2021 17.47
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

My Dear Brother

Sorry brother, I just opened the email .. I have just recovered from self-isolation due to covid symptoms so all activities have stopped. Hopefully the journal can be accepted soon.

Best regards

Syarif

[Kutipan teks disembunyikan]

Muhammad Syarif <muhsyarif00@gmail.com> 28 September 2021 17.58
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

My Dear Brother

I also just saw the email sent by JMR&T on September 17, 2021 and asked for confirmation
of the co-authorship submission to the Journal of Materials Research and Technology.
Title: Converting conventional bonding mortar to high performance nano-carbon bonding mortar.
But it's out of date because I just saw the email. thank you

Best Regards
Syarif
[Kutipan teks disembunyikan]

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 28 September 2021 20.21
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: muhsyarif00@gmail.com

My Dear Brother:

Assalamualaikum wr. wb.

I whole-heartedly hope that you get in well soon.

Because I add your name and credentials into my two papers which is second round of review process in the JMR&T, you have get email confirmation. If the email is valid, please confirm your authorship. If they are not valid, please do not worry because you are in there.

Thank you very much for your patience. In the meantime, I guess that our new cement article is in press process. We will also get its link about its publishing in online first stage in the JMR&T.

And please send me new data and new paper ideas so that I could write and publish them sincerely.

I am looking forward to hearing from you and to working with you collaboratively very much.

With my best wishes and my best regards,
M. Serkan KIRGIZ, Ph.D., M.Sc., B.Sc. P.C.T.
Professor of Materials
Head of Department of Architecture (English)
Nişantaşı University

Sent from Yahoo Mail on Android
[Kutipan teks disembunyikan]

Muhammad Syarif <muhsyarif00@gmail.com> 30 September 2021 03.23
Kepada: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

waalakumsalam..wr..wb..
My dear brother
Professor M. Serkan KIRGIZ, Ph.D., M.Sc., B.Sc. P.C.T.

Thank you for your prayers .. I hope that the cement article that has gone through a long struggle that has been approved by reviewers and editors can be published soon .. and hopefully the grammar as directed by the editor will no longer be a problem ...

Best Regards

Syarif
[Kutipan teks disembunyikan]

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 30 September 2021 05.13
Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>
Kepada: Muhammad Syarif <muhsyarif00@gmail.com>

Assalamualaikum wr. wb. My Dear Brother:

After your email I got, I have sent an email to ask the status of our new cement paper in the JMR&T. Because I did not get any response from Dr. Galdino, I did not give you any promising news about its publishing stage.

However, I whole-heartedly hope that the paper will be published by the JMR&T very soon because we did correct and revise and make all changes wished. So, I am sure that the Editor will satisfy the paper we revised.

In the meantime, please send me your new data and paper idea so that I could write and prepare new articles as soon as possible.

Thank you in advance.

I am looking forward to hearing from you and to working with you collaboratively very much.

With my best wishes and my best regards,

Gmail

Muhammad Syarif <muhsyarif00@gmail.com>

Fw: ENC: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R3

1 pesan

Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com> 30 September 2021 11.10

Balas Ke: Mehmet Serkan KIRGIZ PhD <nakres42@yahoo.com>

Kepada: Gobinath Ravindran <gobinath.research@gmail.com>, Muhammad Syarif <muhsyarif00@gmail.com>, "Prof. Anwar Khitab" <anwar.khitab@gmail.com>, Said Kenai <sdkenai@yahoo.com>, Jmkhatib <jmkhatib@yahoo.com>, Jamal El Khatib <j.khatib@bau.edu.lb>, Jamal Khatib <j.m.khatib@wlv.ac.uk>, John Kinuthia <john.kinuthia@southwales.ac.uk>, Professor Hesham El NAGGAR <naggar@uwo.ca>, Moncef Nehdi <mnehdi@uwo.ca>, Ahmed Ashteyat <a.ashteyat@ju.edu.jo>, Ahmed Soliman <ahmed.soliman@concordia.ca>, "manoj.kumbhalkar@rediffmail.com" <manoj.kumbhalkar@rediffmail.com>, Chandra Sekhar Tiwary <chandra.tiwary@metal.iitkgp.ac.in>, Ami Tagbor <amitagbor@yahoo.co.uk>, Jahangir Mirza <mirza7861@gmail.com>, "KHAIRUNISA BINTI MUTHUSAMY ." <khairunisa@ump.edu.my>, Engr Naraindas Bheel <naraindas04@gmail.com>, "wuyankai2000@163.com" <wuyankai2000@163.com>, Carlos Thomas Garcia <carlos.thomas@unican.es>, Tuan Anh Nguyen <ntanh2007@gmail.com>, "Dr. Muhammad Irfan Ul Hassan" <irfanulhassan@uet.edu.pk>

Sent from Yahoo Mail on Android

----- Forwarded Message -----
From: "Mehmet Serkan KIRGIZ PhD" <nakres42@yahoo.com>
To: "andre.galdino@ifes.edu.br" <andre.galdino@ifes.edu.br>
Sent: Thu, Sep 30, 2021 at 21:05
Subject: Re: ENC: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R3

Hello, André:

Thank you very much indeed. Congratulations you as well!

With my best wishes and my best regards,
Serkan

Sent from Yahoo Mail on Android

On Thu, Sep 30, 2021 at 20:00, Andre Gustavo de Sousa Galdino <andre.galdino@ifes.edu.br> wrote

> Hello, Serkan!
>
> Here is the decision about JMRT-D-21-01643R3.
>
> My best regards and my best wishes,
>
> André Gustavo de Sousa Galdino, D.Sc.
> Professor EBTT
> Coordenadoria de Mecânica
> Instituto Federal do Espírito Santo – Campus Vitória
> 27 3331 2100 ramal 2160
>
>

De: em.jmrt.0.7655cf.420e79aa@editorialmanager.com [em.jmrt.0.7655cf.420e79aa@editorialmanager.com] em nome de Journal of Materials Research and Technology [em@editorialmanager.com]
Enviado: quinta-feira, 30 de setembro de 2021 0:05
Para: Andre Gustavo de Sousa Galdino
Assunto: Decision on submission to Journal of Materials Research and Technology - JMRT-D-21-01643R3

Manuscript Number: JMRT-D-21-01643R3

Development and assessment of cement and concrete made of the burning of quinary by-product

Dear Dr. Galdino,

Thank you for resubmitting your manuscript to Journal of Materials Research and Technology.

I am pleased to inform you that your manuscript has been accepted for publication.

Your accepted manuscript will now be transferred to our production department. We will create a proof which you will be asked to check, and you will also be asked to complete a number of online forms required for publication. If we need additional information from you during the production process, we will contact you directly.

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Dear Prof. Serkan

Thank you the excellent outcomes. Many Congratulations.

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Jamal

Professor Jamal Khatib,

BEng, MEng(Sc), PhD, HonProf$_{(IMUST)}$, CEng, EUR ING, FICE, MIEI (till 2015), M-EPSRC-APRC, MEPC, MOIA, FHEA, MIRED, SMUACSE, PGCert-Ed, PGCert-PjtMgt, Cert-EnvMgt.

Professor of Civil Engineering (Construction Materials),

University of Wolverhampton

Faculty of Science and Engineering

Wulfruna Street

Wolverhampton

WV1 1LY

UK

Email: j.m.khatib@wlv.ac.uk

Honorary Professor: Inner Mongolia University of Science and Technology, China

Visiting Professor: University of La Rochelle, France

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Thanks Prof. Mehmet for your consideration. Millions of Congratulations to you and your efforts.
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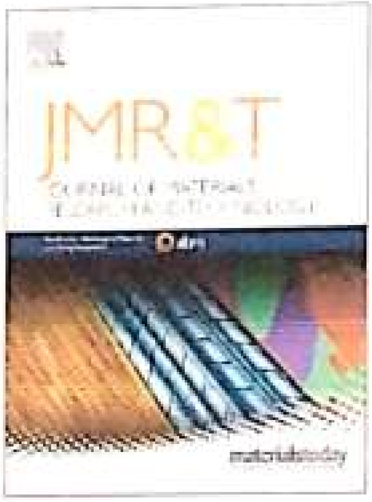

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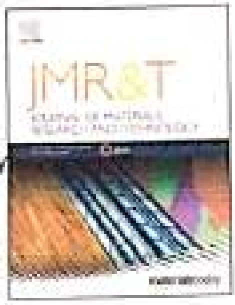

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Development and assessment of cement and concrete made of the burning of quinary by-product

OrcID: Galdino, André Gustavo de Sousa - http://orcid.org/0000-0002-5990-0287

Development and assessment of cement and concrete made of the burning of quinary by-product

Muhammad Syarif[1], Mehmet Serkan Kırgız[2], André Gustavo de Sousa Galdino[3,*], M. Hesham El Naggar[4], Jahangir Mirza[5], Jamal Khatib[6], Said Kenai[7], Moncef Nehdi[8], John Kinuthia[9], Anwar Khitab[10], Carlos Thomas[11], Ravindran Gobinath[12], Muhammad Irfan Ul Hassan[13], Yan Kai Wu[14], Ahmed Ashteyat[15], Ahmed Soliman[16], Khairunisa Muthusamy[17], Thaarrini Janardhanan[18], Trinity Ama Tagbor[19], Tuan Anh Nguyen[20], Naraindas Bheel[21], Manoj A. Kumbhalkar[22], Chandra Sekhar Tiwary[23]

[1]Department of Architecture, Universitas Muhammadiyah Makassar, Jl. Sultan Alauddin No. 259, Gn. Sari, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90221, Indonesia

[2]Department of Architecture, Engineering Architecture Faculty, Nisantasi University, Maslak Mahallesi, Taşyoncası Sokak, No: 1V ve No:1Y Bina Kodu: 34481742, 34398, İstanbul, Turkey

[3]Federal Institute of Education, Science and Technology of Espirito Santo, Av. Vitória, 1729, Jucutuquara, Vitória, ES, 29040-780, Brazil

[4]Department of Civil and Environmental Engineering, Faculty of Engineering, Western University, 1151 Richmond St, London, ON N6A 3K7, Canada

[5]Faculty of Civil and Environmental Engineering, York University, 4700 Keele St, Toronto, ON M3J 1P3, Canada

[6]Department of Civil and Environmental Engineering, Faculty of Engineering, Beirut Arab University, Riad El Solh, 11072809, Beirut, Lebanon.

[7]Geomaterials and Civil Engineering Laboratory, Civil Engineering Department, University of Blida 1, Route de Soumaa; Blida, Blida, 09022, Algeria.

[8]Department of Civil and Environmental Engineering, Faculty of Engineering, Western University, 1151 Richmond St, London, ON N6A 3K7, Canada

[9]Advanced Materials Testing Centre (AMTeC), University of South Wales, Treforest campus, Llantwit Rd, Pontypridd CF37 1DL, United Kingdom

[10]Department of Civil Engineering, Mirpur University of Science and Technology, Mirpur AJK, Pakistan
[11]LADICIM (Laboratory of Materials Science and Engineering), University of Cantabria, 39005 Santander, Spain.
[12]SR Engineering College, Warangal, Telangana 456, India
[13]University of Engineering and Technology, Civil Engineering Department, Lahore, Pakistan
[14]Shandong Provincial Key Laboratory of Civil Engineering Disaster Prevention and Mitigation, Qingdao 266590, China
[15]Civil Engineering Department, University of Jordan, Amman, Jordan
[16]Department of Building, Civil, and Environmental Engineering, Gina Cody School of Engineering and Computer Science, Concordia University, Montreal, Quebec, Canada
[17]Faculty of Civil Engineering Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Pahang, Malaysia
[18]Department of Civil Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, Tamilnadu, India
[19]Council for Scientific and Industrial Research- Institute of Industrial Research, P. O. Box LG 576 Legon, Accra, Ghana
[20]Institute for Tropical Technology, Vietnam Academy of Science and Technology, Vietnam
[21]Department of Civil and Environmental Engineering, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, Tronoh, Perak, 31750, Malaysia
[22]Dept. of Mechanical Engineering, JSPM Narhe Technical Campus, Pune 411041, India
[23]School of Nano Science and Technology, Indian Institute of Technology, Kharagpur, West Bengal 721302, India

muhsyarif00@gmail.com, nakres42@yahoo.com, andregsg@ifes.edu.br, naggar@uwo.ca, mirza7861@gmail.com, jmkhatib@yahoo.com, sdkenai@yahoo.com, mnehdi@eng.uwo.ca, john.kinuthia@southwales.ac.uk, anwar.khitab@gmail.com, carlos.thomas@unican.es, gobinath.research@gmail.com, irfanulhassan@uet.edu.pk, wuyankai2000@163.com, a.ashteyat@ju.edu.jo, ahmed.soliman@concordia.ca, khairunisa@ump.edu.my, whiterose.naren@gmail.com, amitagbor@yahoo.co.uk, ntanh@itt.vast.vn, naraindas04@gmail.com, manoj.kumbhalkar@rediffmail.com, chandra.tiwary@metal.iitkgp.ac.in

* Corresponding author

ABSTRACT

The aim of this study is to evaluate the usability of new cement (NC) made by the burning of quinary by-product to make commercial binders. Chemical analysis of the by-products and NC as well as X-ray diffraction (XRD) analysis of NC, fineness, density, consistency, and setting time of NC paste, and slump in addition to compressive strength (CS) and splitting tensile strength (STS) of NC concrete (NCC) were conducted. The results suggested that chemical composition of by-products is suitable to make NC binder. The NC contains Ca_3SiO_5, Ca_2SiO_5, $Ca_3Al_2O_6$, and $Ca_3Al_2FeO_{10}$. The particles passing through the 200 um Sieve were 56% compared with 52% for Portland cement (PC). The density of the of NC was similar to that of PC. The NC needed 48% more water than PC for normal consistency. The initial and final setting-time of NC was 105 min and 225 min respectively which is much higher than that of PC (15 and 45 min). The slump, compressive strength and splitting tensile strength were slightly lower for concrete containing NC compared with that pf PC concrete. Although the CS and STS of NCC are the lowest, the rate of the CS and STS gain of NCC is greater than that of PCC. It was concluded that NC is a viable alternative to PC for the production of greener concrete.

Keywords: Household waste; calcined clay waste; alternative cement; fly ash; bottom ash; Mediterranean soil

1. Introduction

In 2020, the World Bank reported that 2.01 billion tons of the municipal solid waste (MSW) are generated annually in the world, and approximately 230 million tons of it was burned. It is expected that the global municipal solid waste will grow to 3.46 billion tons by 2050 [1]. Considering the fact related to the municipal solid waste, coal bottom ash is another waste material generated by power plants. The annual production of coal bottom ash (CBA) is 25 million tons of coal bottom ash (CBA) in India [2], 14 million tons in US, 4 million tons in Europe [3] and about 1.7 million tons in Malaysia [4] which creates environmental problems for the global society. The majority of CBA is used as landfill material and there is no effort to transform it into construction material or other useful products. This situation is not different for pulverized fuel ash (PFA) where 360 million tons of PFA are generated every year and most of the waste (216 million tons) are still stored on the land. According to the United States Environmental Protection Agency (EPA), the use of PFA for landfilling and for construction materials is not harmful to ground water resources [5]. Therefore, using PFA in concrete can reduce the amount sent to landfill and generate income for the producer which is currently between US$ 20 and 45 per ton. In Europe, according to the European Union (EU) report presented in 2011, the amount of construction and demolition waste (CDW) generated annually in Europe is approximately 1 billion tons, including waste calcined clay brick remnant (WCCBR) [7]. Conventional method to overcome WCCBR is through dumping in landfills which is also expensive. The cost of recycling of one ton of CDW, concrete, brick, and masonry remnants, is about $21/ton, whilst the cost of landfilling is about $136/ton [8]. Mediterranean soil, and rock contain high amount of lime component which is essential for cement production. Additionally, cement manufacturing system releases large amounts of CO_2 into the atmosphere through combustion of fossil fuels and the decomposition of calcium carbonates. This release leads to approximately 7% of total green-house gas (G-HG) emission in the world. Reduction of CO_2 emission due to cement manufacturing can be achieved through: (a) minimizing clinker quantity and increasing the supplementary cementitious materials (SCM) quantity; (b) manufacturing of innovative cement; (c) developing existing cement plants with renewable energy resources, to create new alternative fuels (e.g., bio-mass and waste materials in the burning steps) and (d) making capturing of CO_2 emission during cement manufacturing and its reuse in the production of cement and cement-based material [9].

Supplementary cementitious materials (SCM) can be used to minimize the clinker quantity. These include the use of rice rusk ash, palm oil fuel ash, bagasse ash, blast furnace slag, coal fly ash, steel slag and silica fume [10-17]. Using more than one type of waste as supplementary cement materials is not very common. Kikushi [18] used solid waste incineration ash for the production of cement and recommended the use of approximately 50% of this waste can used as raw materials. This process of manufacturing does not lead to secondary pollution in air, earth and water. In 2018 Joseph et al. [19] reported that huge quantities of the municipal solid waste (MSW) are generated annually and most of it is sent to landfill. Therefore, using MSW in the manufacture of cement will reduce the quantity sent to landfill and the associated pollution.

In 2014, the European Cement Research Academy [20] reported that the compressive strength of grout containing cement manufactured using kaolinite clay as one of raw materials was higher than that using traditional cement. Apart from the burning process to dispose the waste, another significant study was carried out by Ferraro et al. [21] to produce lightweight aggregate with waste and to minimize risks related to disposal of waste. Analysis of cold-bonding method gave a broad outcome on the treatment and reuse of waste materials productively. Additionally, it presented an important way to decide optimization of waste usefully for both producers and researchers who would like to work on the cold-bonding method.

BS EN 197-1 standard [22] specifies limits for the oxide composition of new cements; the CaO-SiO_2 ratio (by mass) should not be lower than 2 and the magnesium oxide and the loss on ignition should not be greater than 5%. However, there has no standard limit for heavy metal leaching for cement and cement-based materials [22].

This paper examines the properties of an innovative cement made of more than one type of by-products. The raw materials used for the production of clinker are; pulverized fuel ash, bottom ash, calcined clay waste, Mediterranean soil and household waste ash. To the authors knowledge, there is no research combining more than two waste materials mentioned above in the production of a new cement. The properties of the new cement included fineness, density, consistency, setting-time, chemical component, mineralogy of new cement, and workability, compressive strength, and splitting tensile strength.

2. Materials and methods

2.1 Research procedures

The study was planned in four stages. First stage is related to measure chemical components of by-products (coal bottom ash, coal fly ash, household waste, Mediterranean soil, calcined clay) according to ASTM C 114-18 [23]. This stage is called as description stage of by-products. Figure 1 illustrates various wastes and natural raw materials, and new clinker and cement manufactured.

Figure 1. Various wastes and natural raw materials, and new clinker and cement manufactured.

Second stage deals with manufacturing new cement with burning the farina which was prepared with quinary by-product. New cement was called as organic cement.

Third stage scope is measurement of new cement specifications, such as chemical components, water demand, fineness, density, setting-time, mineralogy with X-ray powder diffraction (XRD). The specifications were determined according to ASTM C 114-18 [23], ASTM C 187-04 [24], ASTM C 204-18e1 [25], ASTM C 188-95 [26], ASTM C 191-19 [27], ASTM C 1365-18 [28].

Fourth stage deals with manufacturing concrete specimens made of new organic cement and measurement of their slump, compressive strength, and splitting tensile strength. The compressive strength measurement was performed at 3, 7, 14, 21, and 28 days, and the splitting tensile strength measurement was carried out at 28 days. The properties were determined according to ASTM C 143/C 143M-20 [29], ASTM C 39/C 39M-21 [30], and ASTM C 496/C 496M-17 [31].

The empirical Eq. (1) was used with the by-products mentioned previously to obtain farina.

$$\sum R_{If} = \frac{\sum S + \sum I \sum N \sum A \sum R}{100} \quad (1)$$

Where $\sum Rif$ is the new cement concentrate (kg); $\sum S$ is the Mediterranean soil concentrate (%); $\sum I$ is the calcined clay waste concentrate (%); $\sum N$ is the household waste concentrate (%); $\sum A$ is the fly ash concentrate (%); and $\sum R$ is the bottom ash concentrate (%).

To manufacture new cement clinker, the farina (combination of Mediterranean soil, household by-product, calcined clay by-product, fuel ash, and bottom ash) prepared by Eq. (1) was burned at 1375 °C, maintained for four hours and cooled in the laboratory. This new clinker was mixed with 2 wt% gypsum and ground to make the new cement. Figure 2 shows the clinkerization from the waste concentrate used in the study and Figure 3 shows the cement raw material before the combustion process to become the cement concentrate.

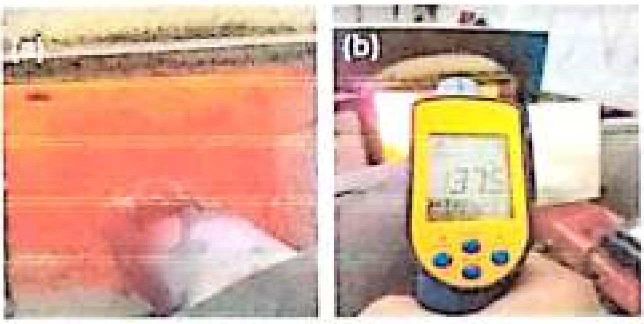

Figure 2. The clinkerization from the waste concentrate used in the study: (a) furnace; (b) process temperature.

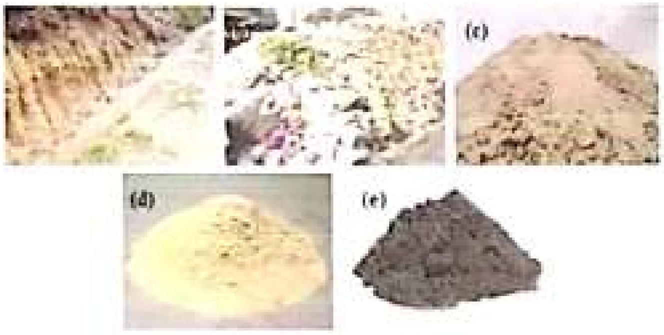

Figure 3. The cement raw material before the combustion process to become the cement concentrate: (a) the Mediterranean soil; (b) the household waste; (c) the calcined clay; (d) the pulverized fuel ash; and (e) the bottom ash.

The percentage of the main ingredients used in the new cement forming is shown in Table 1 below.

Table 1. Percentage of new cement forming

No	Material Source	Main composition (Major)			Additional chemical elements (minor)
		Major chemical elements	Material Source	Material Used elements	
1.	Mediterranean Soil /S	CaO	60.93	54	SiO_2, Al_2O_3, Fe_2O_3, Mgo, SO_3, Na_2O, K_2O
2.	Clay / I	SiO_2	30.63	10	SiO_2, Al_2O_3, Fe_2O_3, CaO, Na_2O, K_2O, MgO, SO_3
3.	Fly Ash / N	SiO_2	22.14	4	Al_2O_3, CaO, Fe_2O_3, SO_3, Na_2O, K_2O, MnO, MgO, TiO_2
4.	Bottom Ash / A	SiO_2	15.20	4	CaO, Al_2O_3, Fe_2O_3, MgO, K_2O, Na2O
5.	Household waste /R	SiO_2	46.65	28	CaO, Al_2O_3, Fe_2O_3, MgO, K_2O, TiO_2, Na_2O, P_2O_5

2.2 Methods

2.2.1 Chemical component test of by-products and new cement

Chemical composition of Mediterranean soil, household by-product, calcined clay by-product, fuel ash, and bottom ash was determined according to ASTM C114-18 [31] standard, which is known the wet chemical analysis method. Chemical component of the new cement was determined by using the Energy Dispersive X-Ray Fluorescence method.

2.2.2 XRD analysis

Mineralogy of new cement was conducted by XRD analysis according to ASTM C1365-18 [20]. Equations of Bogue calculation and being created of such Bogue chemical compounds as the C_3S, the C_2S, the C_3A and the C_4AF led to some discussion related to the strength gain mechanism of cement-based materials. In the light of the discussion, some comprehensive studies, which used X-ray powder diffraction (XRD), investigate mineral compound of new cement according to ASTM C1365-18 [28]. Bragg equation (Eq. (2)) was used to calculate diffraction angle of X-rays dispersed from sample.

$$n\lambda = 2d \cdot \sin\theta \quad (2)$$

Where the symbol of θ is a diffraction angle of material, the symbol of n is a constant, the symbol of λ is a wavelength of the X-ray scattered from new cement, and the symbol of d is a distance between two adjacent parallel lattice planes in the inner crystal structure.

2.2.3 Fineness test

For establishing the size of cement particle firstly, sieve analysis was conducted with a 200-mesh sieve. In accordance with ASTM C 204-18e1 standard [23], fineness of new cement was determined with the following processes: (1) get some specimen from new cement, (2) scrub the specimen to prevent lumps, (3) have a weigh of 100 g specimen and make it note as (W_1), (4) put the 100 g of specimen on the 200 mesh sieve, and make its lid covered, (5) vibrate the sieve for fifteen (min) (6) have a weigh of residue left on the 200 mesh sieve, and make it note as (W_2), (7) make the left percentage of weight of cement calculate with Eq. (3) and note as (W_t). The test was repeated the mentioned processes with three different specimens of new cement. The presented fineness result is the average quantity of new cement as descriptive statistic.

$$W_t = \frac{W_2}{W_1} x\ 100\ (3)$$

2.2.4 Density test

Density of new cement and Portland cement was measured according to ASTM C 188-95 standard [26]. The following processes were employed in the test; (1) have a weigh of clean and dry the Le Chatelier flask and make it record as (W_1), (2) fill the new cement specimen up to half of the flask (approximately 50 mg), (3) have a weigh of the Le Chatelier flask along with the specimen and make it note as (W_2), (4) add kerosene into the flask until the flask is almost full of half, (5) make the flask blend thoroughly to remove air entrapped, (6) continue the blending of flask and add kerosene until the flask is filled up the graduated mark, (7) make the flask outside dry and get a weigh of flask and note it as (W_3), (8) discharge the flask and make it dry, (9) fill the kerosene into the flask with the graduated mark, (10) make the flask outside dry and have a weigh of the flask with kerosene and note it as (W_4). The density of new cement and Portland cement was calculated along with the following Eq. (4) as will be seen below.

$$\gamma = \frac{(W_2-W_1)}{[(W_2-W_1)-(W_3-W_4)]x\,0.79}\ (4)$$

In Eq. 4, γ is the density of cement as g/cm^3 and the density of kerosene is 0.79 g/cm^3 was used.

2.2.5 Consistency test

Consistency test of new cement paste and Portland cement paste was conducted to establish the need of water to reach the normal consistency of cement paste. The consistency of new cement paste and Portland cement paste was performed according to ASTM C 187-04 standard [24]. Following process summarizes the test; (1) have a weigh of 400 g specimen and put it in a bowl along with lid (2) make the specimen prevented humidity, (3) put 28% of water by mass of cement specimen and blend it, (4) continue blending cement paste for 3 to 5 min, (5) fill up the cement paste in the Vicat mold, (6) make the plunger touched the surface of cement paste in the Vicat mold, (7) let the plunger fall to sink into the test mold, (8) make the penetration depth of the plunger from the bottom of mold record, as indicated on the scale of Vicat, (9) repeat the same test along with new paste which was made of different percentages of water until the penetration depth of plunger reaches a degree among 5 to 7 mm. Three different specimens of cement paste were used to repeat the processes of consistency mentioned above, to make it recorded as an average result of consistency.

2.2.6 Setting-time test

According to ASTM C 191-19 standard [27], the setting-time of new cement paste and Portland cement paste was performed as follows: (1) have a weigh of 400 g of specimen from cement (2) make the specimen placed in a bowl along with lid to prevent humidity, (3) put three fifths milliliters of water by mass of cement in the bowl, (4) blend the water and cement specimen, (5) fill the cement paste up Vicat mold, (6) make the plunger of Vicat touched on the surface of cement paste, (7) let the plunger drop to sink into the test mold, (8) make the penetration depth of the plunger from the bottom of mold recorded, as indicated on the scale of Vicat, (9) do again the dropping of plunger at different places on the surface of cement paste until the plunger ceases penetrating 25 ± 2 mm from the bottom of the Vicat mold. At 5 ± 2 mm penetration depth, it is the time for the initial time of setting of the cement paste, (10) record the time for the final setting-time once the plunger is not sinking 0 ± 2 mm from the upper surface of cement paste in the Vicat mold.

2.2.7 Slump test

Slump of concrete was determined according to ASTM C 143/C 143M-20 standard [29]. To obtain the required workability, a mix design was made as shown in Table 2.

Table 2. Details of the concrete mixes

Types of material	w/c	Proportion of materials (kg/m^3)				Target slump height planned (mm)
		Water	Cement	Materials		
				FA*	CA**	
New cement concrete	0.52	195	375	538	1232	120
Portland cement concrete	0.52	195	375	538	1232	120

*Fine aggregates (FA) ≤ 2.5 mm; **Coarse aggregates (CA) ≤ 20 mm

2.2.8 Compressive strength test

Compressive strength of concrete was determined according to ASTM C39 / C39M-21 standard [30]. The compressive strength of cylinder concrete was calculated according to Eq. (5).

$$\sigma = \frac{P}{A} \quad (5)$$

Where the σ is the compressive strength of concrete (MPa), P is the compressive force in failure (N), and A is the cross-sectional field of concrete used (mm^2).

2.2.9 Splitting tensile strength test

Splitting tensile strength of concrete was determined according to ASTM C496 / C496M-17 standard [31]. The splitting tensile strength was calculated according to Eq. (6).

$$f_{ct} = \frac{2 \times P}{L \times D} \quad (6)$$

Where the f_{ct} is the splitting tensile strength (MPa), P is the maximum force in failure (N), L is the length of concrete specimen (mm), and D is the diameter of concrete specimen (mm).

3. Results and discussions

3.1 Chemical composition of by-products

The wet analysis method was used to determine the chemical composition of the binder. This includes the by-product materials such as Mediterranean soil, house hold waste, calcined clay, fly ash and bottom ash. Table 3 shows the chemical composition results of various by-products used in the manufacturing of new cement.

Table 3. Chemical composition of the by-products used in the manufacturing of new cement

Chemical compound	Chemical composition (%)				
	Mediterranean soil	Household waste	Calcined clay	Fly ash	Bottom ash
SiO_2	60.93	46.65	30.63	22.14	15.2
Al_2O_3	0.44	2.28	3.41	3.84	2.99
Fe_2O_3	0.15	0.18	0.20	0.20	0.20
CaO	19.35	11.09	0.51	6.87	1.41
SO_3	1.66	1.01	0.36	0.89	0.15
Na_2O	0.01	2.24	0.01	0.37	1.03
K_2O	0.09	11.98	0.23	0.58	0.17
MgO	0.018	0.02	0.02	0.03	0.02
P_2O_5	N/A	0.47	N/A	N/A	N/A
LOI	N/A	N/A	N/A	N/A	N/A

The N/A stands for the "Not available" and the LOI stands for the "Loss on ignition" in the chemistry of cement.

If it is necessary, the technique which includes separation and isolation is applied to the specimen. The methods of stoichiometric, such as the gravimetric method and the volumetric method, are used in the wet chemical analysis to get the quantitative elements and chemical compounds of the specimen. There are two wet chemical analysis types. The first is the qualitative analysis that establishes which elements are in the specimen, and the second is the quantitative analysis which gives the quantity of elements in the specimen. Almalkawi et al. in 2019 [32] recommended that the use of industrial by-product in geopolymer binder as a green construction material is beneficial and used the wet analysis method for the determination of the chemical components. The study's results proved that ternary blend of by-products could be used to make hydraulic geopolymer binder along with the strength and the upcycling targeted.

Another study on by-product packing glass by bottle, which is similar to Almalkawi et al. was conducted by Ibrahim and Meawad in 2018 [33] and the authors also used the wet chemistry method for the chemical composition of the by-products. Their results revealed that the powder of by-product which was obtained from uncolored glass, green glass, and brown glass is available to make supplementary cementitious materials, and their ions are responsible for their color do not have an effect on the binder properties negatively. ASTM C618-19 standard [34] identified that fly ash pozzolan used has to include more than 70 wt% of silicon oxide (SiO_2) + aluminum oxide (Al_2O_3) + iron oxide (Fe_2O_3) in total. In the current study, the content of SiO_2, Al_2O_3, Fe_2O_3 and calcium oxide (CaO) suggests valuable chemical component and potential for new hydraulic binder, and will let the new cement develop strength gain slowly.

There are other studies that show the necessity of the chemical component identification for new material and conventional binder. One of them is an important study reported by Ruiz-Sánchez et al. in 2019 [35], entitled "Waste marble dust: An interesting residue to produce cement". This study made six clinker types through by-product of marble powder. In order to better examine the chemistry of new binder, they performed the wet chemical analysis on the binder. The results revealed that the chemical component of by-product of marble powder consists of the major presence of CaO, and its physico-chemical analysis confirmed its feasibility, pureness, and cleanness. Additionally, another work conducted by Kirgiz [36] also demonstrated that chemical component of cement manufacturing with burning marble powder and brick powder is essential to decide on this method's usefulness. The works mentioned above support the current work in term of chemical component necessity once new hydraulic cement is manufactured.

3.2 Chemical component

Table 4 shows chemical component of new cement, its comparison with Portland cement, and the limits in chemical component of hydraulic binder according to BS EN 197-1:2011 standard [22]. Chemical component performed by XRF was identified and enumerated with the X-ray radiation reflecting from the material with photoelectric way. The way of photoelectric catches the gamma radiation of X-ray because the electrons are spread from atoms in the specimen through high-energy collisions.

Table 4. Chemical component of the new cement, its comparison with Portland cement, and the limits in chemical component of hydraulic binder to BS EN 197-1:2011 standard [22]

Chemical component	New cement (%)	Portland cement (%)	The limits in chemical component of hydraulic binder to BS EN 197-1:2011 (%) [14]
Alite (C_3S)	69.9	50-70	–
Belite (C_2S)	7.3	15-30	–
Tri calcium aluminate (C_3A)	10.3	5-10	–
Brownmillerite (C_4AF)	3.1	5-15	–
Silicon oxide (SiO_2)	21.29	20.6	–
Aluminum oxide (Al_2O_3)	7.86	5.07	–
Iron oxide (Fe_2O_3)	4.4	2.9	–
Calcium oxide (CaO)	68.43	63.9	–
Sulfate oxide (SO_3)	3.2	2.53	≤ 5
Sodium + Potassium oxide Na_2O+K_2O	1.58	0.88	≤ 2
Magnesium oxide (MgO)	4.8	1.53	≤ 5
Loss on ignition (LOI)	1.03	1.58	≤ 5

ASTM C 114-18 standard [23] was known as the guideline for this test because the reference is a normative reference which is considerably relevant to the process of chemical component testing of cement. In Table 3, new cement shows that all the limits presented by BS EN 197-1:2011 standard [22] are satisfied. The major ingredient of new cement consists of, as shown in the Table 3, the calcium and silicon oxides (greater than 89.7% in total). This quantity of such oxides makes new cement get hydraulic binder properties. Moreover, because of surplus of C_3S, new hydraulic cement can be sorted as an alite along with minor content of belite, tri calcium aluminate, and brownmillerite.

3.3 Microstructural analyses

Figure 4 shows the comparison of XRD results between the new cement and Portland cement. The X-ray diffraction test result of the new cement is, then, analyzed by searching and matching, like being in the references [37, 38, 39, 40].

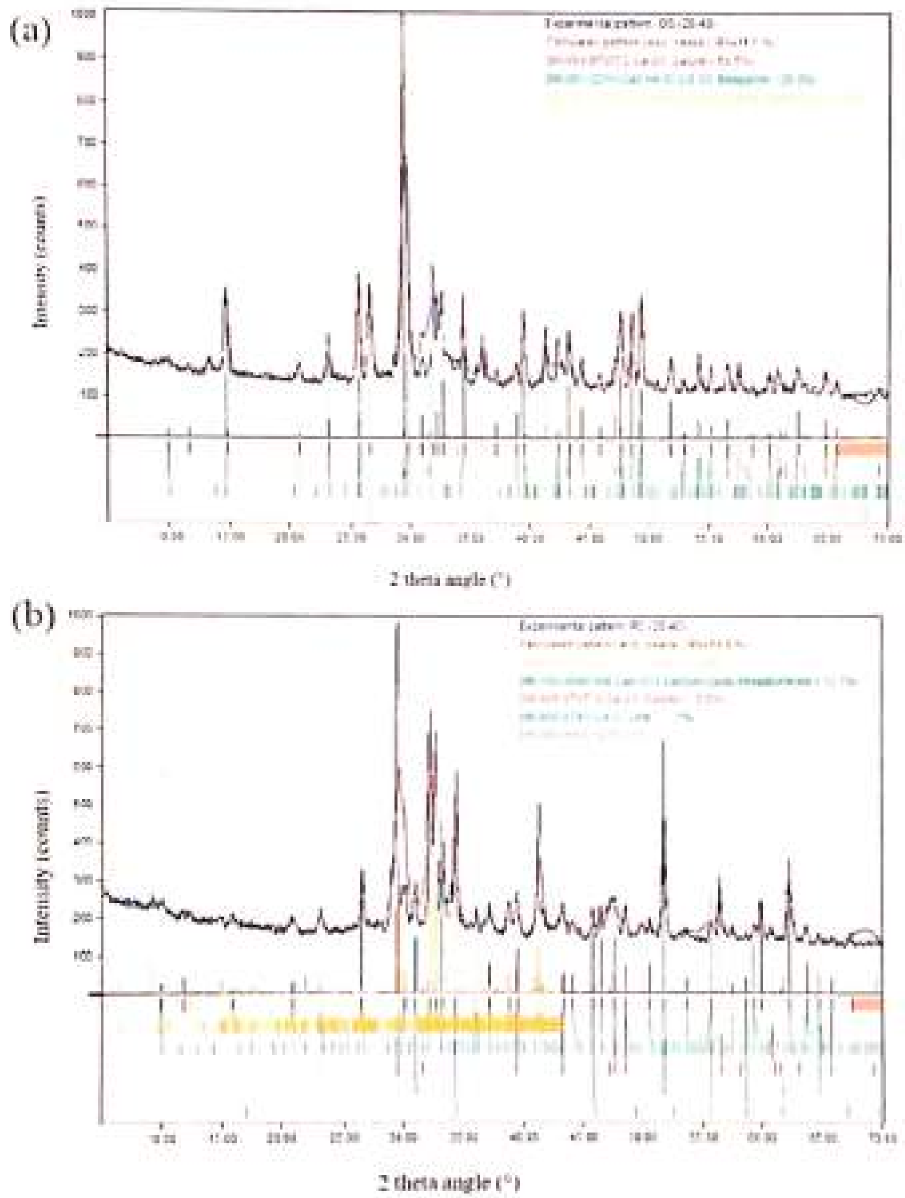

Figure 4. XRD diffractograms of: (a) Portland cement; and (b) new cement.

Additionally, to the result of the searching and matching, it has been concluded that the chemical component of new cement shows similar components as Portland cement. Of all the chemical component presents in the Portland cement, the most important chemical components are alite (Ca_3SiO_5: C_3S stands for tri-calcium silicate), belite (Ca_2 SiO_5: C_2S stands for di-calcium silicate), aluminate ($Ca_3Al_2O_6$: C_3A stands for tri-calcium aluminate, and ferrite ($Ca_4Al_2FeO_{10}$: C_4AF stands for tetra-calcium alumina ferrite). The four chemical components were obtained for the new cement after its combustion at high and controlled temperature at 1375 °C.

SEM/EDX analyses of new cement paste made of the burning of pulverized fuel ash, pulverized bottom ash, household waste, Mediterranean soil, and calcined clay waste are shown in Figure 5.

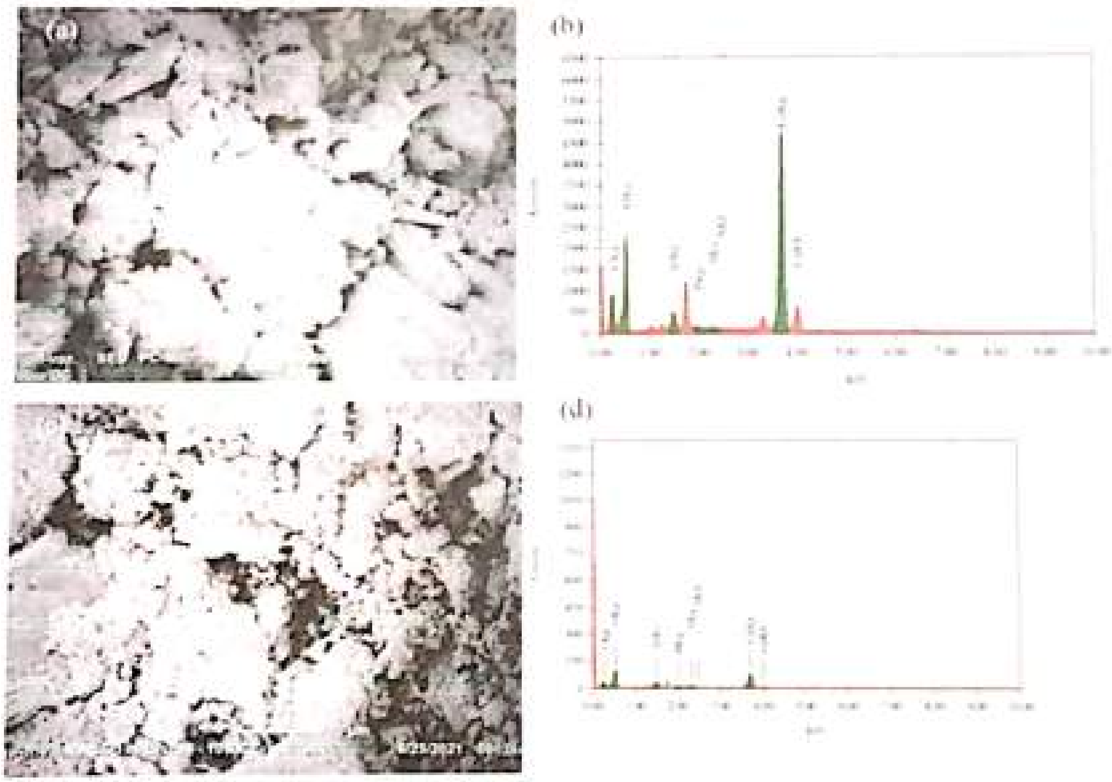

Figure 5. (a) New cement SEM; (b) New cement EDX; (c) Portland cement SEM; (d) Portland cement EDX.

The SEM micrographs in Figure 5 which were taken from paste specimen containing new cement shows the ettringite crystals which were spread into calcium hydroxide. Ettringite is formed in the early age of paste to reduce the flash setting of cement, nevertheless; its meaning is that the hydration of the paste mixing had not been completed, which will lead to an expansion. Therefore, it weakens the interfacial transition zone in cement-based materials. It was observed in hydration of new cement paste, angular cement grains were surrounded by radiating amorph of calcium hydroxide (CH) which resemble the pattern of CH in ordinary cement paste. Randomly oriented portlandite (CH) crystals and prismatic ettringite crystals were widely dispersed throughout the paste. Table 5 shows the chemical elements of new cement paste and ordinary cement paste which were observed in SEM/EDX machine.

However, in the new cement paste, SEM found out that the ettringite prisms were covered with amorphous layered CH hydration products. Matrix phase is mainly composed of short radicular outgrowths of CHs around cement grains and needle-shaped ettringite crystals (Figure 5(a)). Microstructure of hydrated new cement paste was presented by amorphous gel filling spaces between hydrated particles. Moreover, the new cement pastes layered accumulations of the CH crystals which are approximately 10-12 μm in width are intermingled throughout the paste (Figure 5(a)). There is a visible densification around new cement grain, leading to formation of additional C-S-H for later age. Observation of new cement paste demonstrated that the CH phase is found to be richer than C-S-H gel.

Figures 5(c) and 5(d) show SEM and EDX analysis of ordinary Portland cement paste respectively. The ordinary cement paste contains calcium hydroxide (CH), ettringite needles, CSH gel and calcium alumina hydrate (C-A-H).

Table 5 presents EDX results of both new organic cement and Portland cement pastes. From the comparison of chemical elements of new organic cement paste and ordinary Portland cement paste, it can be deduced that their results are similar. This means that both SEM/EDX; wet chemical; and XRD results support the properties of new organic cement and Portland cement pastes.

Table 5. EDX results of new organic cement and Portland cement pastes.

Specimen	Chemical composition (%)					
	Ca	O	Al	C	P	S
New organic cement paste	66.81	29.04	2.18	1.67	0.17	0.13
Portland cement paste	58.07	32.05	6.97	1.11	0.08	1.72

3.4 Fineness

The more fineness is the more cement particles participate in hydration since cement starts hydration process from surface to inside in the cement-based materials. Thus, hydration performance is related to the fineness of cement, and for a rapid gain of strength, the more fineness is a necessity. On the other hand, the greater fineness is the more cost of grinding process is for cement. Moreover, the effect of more fineness on such other properties as slump of fresh concrete, gain of strength and need of gypsum have to be taken into account. Fineness is an important property of binder, and it is necessary to make the fineness be determined with sieve method and specific surface method in m^2/kg according to the rules of BS and ASTM standards. The air permeability method, which makes the pressure drop once dry air flows at a constant velocity through a bed of cement known porosity and thickness determines the specific surface of cement. In 2020, Kumar and Nath [41] suggested that the finer cement, the better are its properties and the better is the development of its microstructure. Kan et al. in 2019 [42], explained the importance of fineness property for cement-based binders. The fineness of new cement and Portland cement determined was given in the Table 6.

Table 6. The fineness of new cement and Portland cement determined in the experimental study

Type of fineness measure	Types of material	
	New cement	Portland cement
200 mesh sieve passing (%)	56	52
Specific surface area (m^2/kg)	1200	1250

The quantity of fineness of new cement is 56% for the 200-mesh sieve passing and 1200 m^2/kg for specific surface area while the quantity of fineness of Portland cement is 52% for the 200-mesh sieve passing and 1250 m^2/kg for specific surface area. The smoother cement is the greater specific surface area is for cement particle. An increase in fineness will accelerate the hydration process with more water demand than that of normal hydration process of Portland cement. Image of new cement and Portland cement is presented in Figure 6.

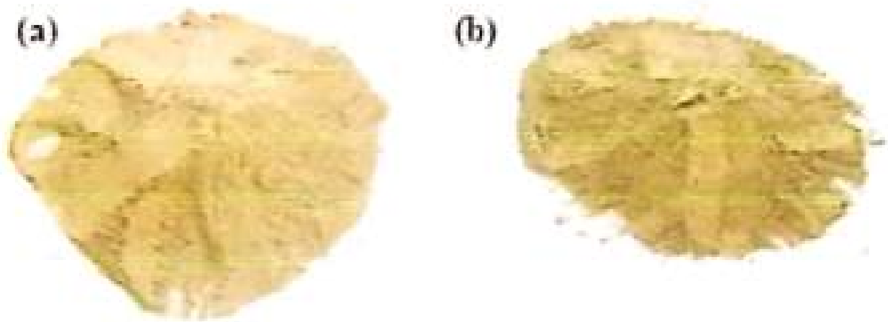

Figure 6. A process of measuring the fineness and the density of cement: (a) new cement; and (b) the Portland cement that is used as a comparator in testing the physical properties.

In concrete mixing, water-to-cement ratio is calculated with water mass/cement mass and usually shorten as w/c. The water-to-cement ratio has a strong effect on the strength gain of concrete. For instance, in a concrete mixture which strength gain was targeted, increase in w/c will decrease the gain of strength at all ages, and decrease in w/c will increase the gain of strength at all ages [43]. In 2019 Ghasemi et al recommended a relationship between the specific surface are of mortar constituent and its flow [44]. Its results revealed that the demand of water in cement-based material is related to the specific surface area of mixture constituents. Estimation of the specific surface area depends on accounting of angularity of particle while content of water and thickness of paste film are essential for estimating the fluidity [44].

3.5 Density

The adaptation of density of cement in connection with vibration and plasticizer could enable more workability for concrete [43]. Comprehensive works, which are taken into account to reach out the targeted final properties of concrete, were conducted on the bulk density of cement as plenty of many theoretical models recommended to estimate the bulk density of cement [46, 47, 48, 49]. The bulk density of Portland cement is 3.15 g/ml while the density of new cement is 3.05 g/ml as will be observed at the current research work. In this case, the ASTM C 188-95 [26] standard formulated the bulk density of cement, and it is valid. Apparent density of fresh concrete with new cement is 2081 kg/m^3 and its dry density is 2032 kg/m^3. The both are lower than that of Portland cement concrete (2525 kg/m^3).
Additionally, these estimation models are depended on the bulk density curve optimization, vibration of cement-based material, and the quantity of ingredient calculation. Firstly, choosing of concrete and cement-based material has to consider the void of side edge in formwork for

construction element, such as column, beam, and floor, so that the void of rust ratio could be filled concrete up. Secondly, the bulk density of materials used in the mixture needs to be known. Lastly, the modelling of bulk density relates to the theoretical density of concrete and cement-based material mixture because this theoretical density could be computed mathematically by determining the bulk density of cement which has different mean size of particle as well [47, 50].

3.6 Consistency

Table 7 shows the result of normal consistency test for the new cement paste and Portland cement paste. The test of normal consistency is referred to ASTM C 187-04 [24].

Table 7. Normal consistency results of new cement paste and Portland cement paste

Type of binder and mixing material quantity		Test of consistency			Average results of consistency (%)
		Specimen I	Specimen II	Specimen III	
Portland cement	Cement (g)	500	500	500	25
	Water (ml)	128	125	122	
New Cement	Cement (g)	500	500	500	37
	Water (ml)	175	180	200	

The importance of consistency test stems from the fact that when water is mixed with cement, its hydration process starts. Surplus addition of water in cement leads up to an increase in water-to-cement ratio, and the increased water reduces the strength of cement paste after it hardens. If less water is added than required, the cement paste composite is not properly hydrated, and the insufficient water content leads up to the loss on the strength, especially the compressive strength. Water has an influence on the workability, strength, shrinkage, and durability of concrete. Normal consistency formed in new cement is a need of 37% water by mass of cement while the need is of 30% water by mass of Portland cement.

3.7 Setting-time

Figure 7 shows initial and final setting time of new cement and Portland cement. As new cement contains 2% gypsum and 98% new clinker, which was prepared by burning compound of Mediterranean soil, calcined clay, bottom ash, fuel ash, and household waste. The new cement hardens slower than Portland cement, as shown in both initial set and final set test results. That setting process of new cement indicates that if it is necessary to harden rapidly, the gypsum percent within the new cement has to be increased.

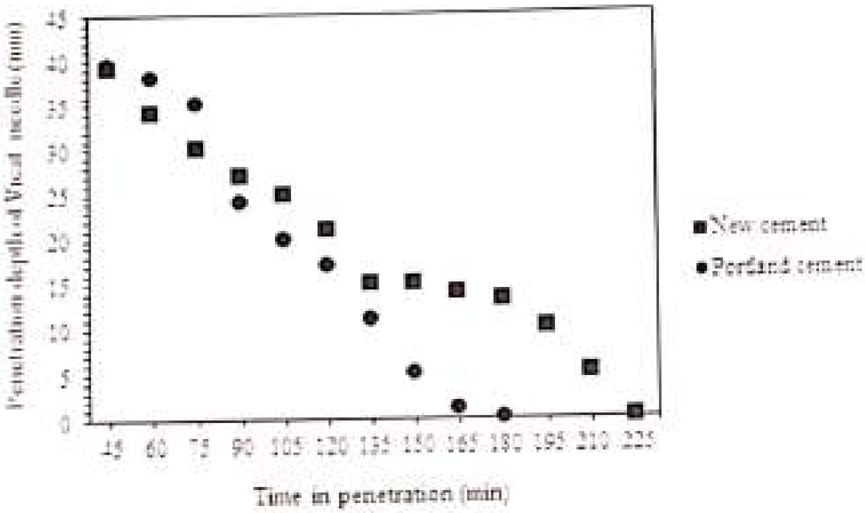

Figure 7. Initial and final setting time of new cement and Portland cement determined

The ASTM C 191-19 [27] defines the required setting-time that it starts when water contacts with cement and continues before chemical reactions cease, even if cement is placed under the water. According to ASTM C 191-19 standard [27], initial setting-time of cement should not start before 75 min. Since the new cement started initial setting-time at 105 min and Portland cement started initial setting-time at 90 min, both new cement and Portland cement obtains the standard rule on initial setting-time according to ASTM C 191-19 standard [27].

At initial setting-time, new cement includes 37% water content while Portland cement contains 25% water content. The more water is the lower consistency is for the new cement and Portland cement. The final setting time of Portland cement is at 180 min, while final setting time of the new cement is at 225 min. Both final setting-time of new cement and of Portland cement enable to obtain standard rule for final setting-time of concrete that it should not be greater than ten hours. As known from literature, C_3A and C_3S starts the setting-time of Portland cement. After that, C_2S hardens the Portland cement gradually. Lastly, C_4AF participates in the setting-time of Portland cement.

As seen in the Table 4, new cement has 55% greater aluminum oxide, 51% greater iron oxide, 3% greater silicon oxide, 7% greater calcium oxide, 24% greater sulfate oxide, and 313% greater magnesium oxide than that of Portland cement. Gypsum content varies between 3% and 5% in the Portland cement. New cement contained 2% gypsum, instead. The difference in chemical component and gypsum content among new cement and Portland cement led to a difference in their setting-times. Apart from rapid and false setting-time and crystalline structure of cement paste, formation of film layer in the surface of cement particles and coagulation of chemical component of cement are two important factors which develop the setting-time. It is clear that the more aluminum oxide component is the more retarding of the setting time of new cement is because it leads to an increase in heat during stiffness process of the new cement. Its setting-time could be accelerated with an increase in gypsum content in new cement. Nevertheless, the initial and final setting-time is suitable for the new cement because it obtains the limit of setting-time which was specified by the BS EN 197-1:2011 standard [22].

3.8 Workability

Slump test of concrete was measured according to the rules of ASTM C 143/C 143M-20 standard method [29]. Slump is the oldest and the most widely known property for monitoring the workability of concrete. Workability of fresh concrete is related to the flow and w/c at microstructure field between cement paste and aggregate during preparing, transport, vibrating, and putting concrete into formwork. Considering the concrete mix, three different types of slump can happen: true slump, shear slump, and collapse slump. True slump depends on levelling of the concrete mass with keeping integrity.

The lack of cohesion in concrete constituent points the shear slump which leads to segregation. The collapse slump is the most dangerous one among the all. It usually points a lean, harsh, and a very wet mix. For example, many modern high-performance concrete buildings were designed for a slump of about 200 mm, which displays collapse slump effect. In in-situ and laboratory, the slump measurements start immediately after water and concrete ingredients contact with each other. In the work, since concrete was prepared at a room temperature of 23 ± 5 °C and of

53% humidity maintained constantly, the determined slump did not affect factors mentioned previously.

Figure 8 shows slump heights of new cement concrete and Portland cement concrete with water-to-cement ratio 0.52 and their standard errors.

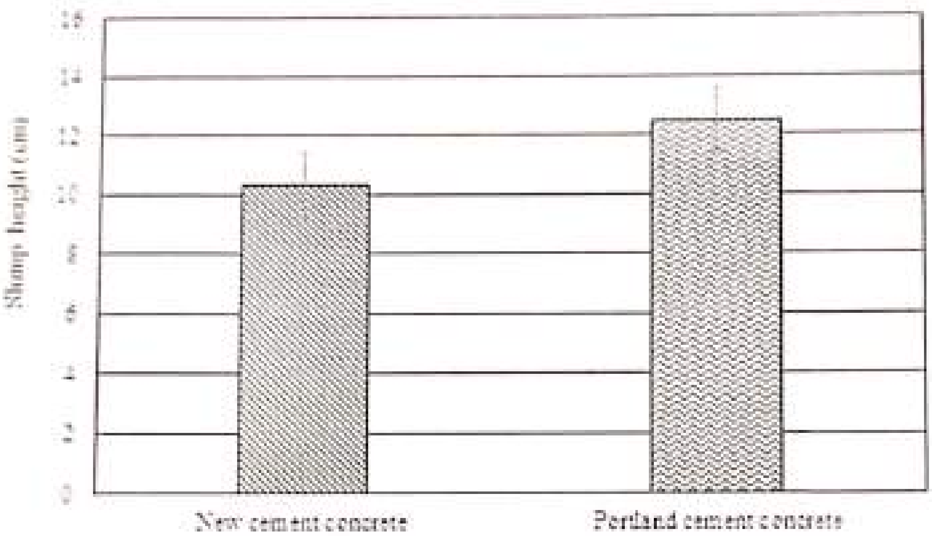

Figure 8. Slump heights of new cement concrete and Portland cement concrete with water-to-cement ratio 0.52 and their standard errors

Additionally, the planned target slump height is 12 cm for both cement concretes. The Portland cement concrete exceeded the target height of slump with only 0.5 cm, while new cement concrete did not reach out to the target, its slump height was 10.3. It is clear that the greater water-to-cement ratio causes a higher slump height in concrete. This is attributed to the fact that water makes cement transform into dye, not binding material. In other words, water breaks up binder property of cement and leads to degrading of the strength of concrete, especially compressive strength.

For that reason, the chosen water-to-cement ratio in the study is enough for both new cement concrete and Portland cement concrete. Since the more water-to-cement ratio will lead to a lower mechanical strength is in concrete at all curing ages and different curing conditions, the ratio of w/c 0.52 would be constant for following sections and the CS and the STS are determined within the given w/c ratio. This will provide standard strength development for new cement concrete, like Portland cement concrete has. Lastly, the workability of concrete is very non-objective.

The workability of concrete was sorted into three classes: qualitative, quantitative empirical and quantitative fundamental. Class I is qualitative method which is based on observation of workability, flowability, compactibility, stability, finishability, pumpability, consistency. Class II is quantitative empirical way which uses simple quantitative tests of slump, compacting factor and Ve–be, instead. Class III is a quantitative method uses viscosity and yield stress. Since slump was determined with quantitative empirical way, workability of new cement concrete is Class II.

3.9 Compressive strength

Mechanical properties depend on many factors in concrete. Major factors are the sample type, size, w/c, and test condition. A number of research measure the property through various sizes of hardened concrete and different water-to-cement (w/c) ratio. This is like comparison of apple with pear because of the fact that the preparation and w/c of concrete are not the same in the mechanical test. In order to prevent compressive strength results from any errors, all conditions regarding on the preparation, size, and w/c, and so on were kept constant in the work. The lines of the test result of compressive strength of cylinder concretes of the new cement concrete and of Portland cement concrete on which dry curing and water curing methods were applied can be seen in Figure 9. The compressive strength of new cement concrete and of Portland cement concrete produced were calculated with the ASTM C-39/39M-21 standard [30] in the reference method that all laboratory uses. For that reason, the results could be repeated in a laboratory that can be found in any part of the world.

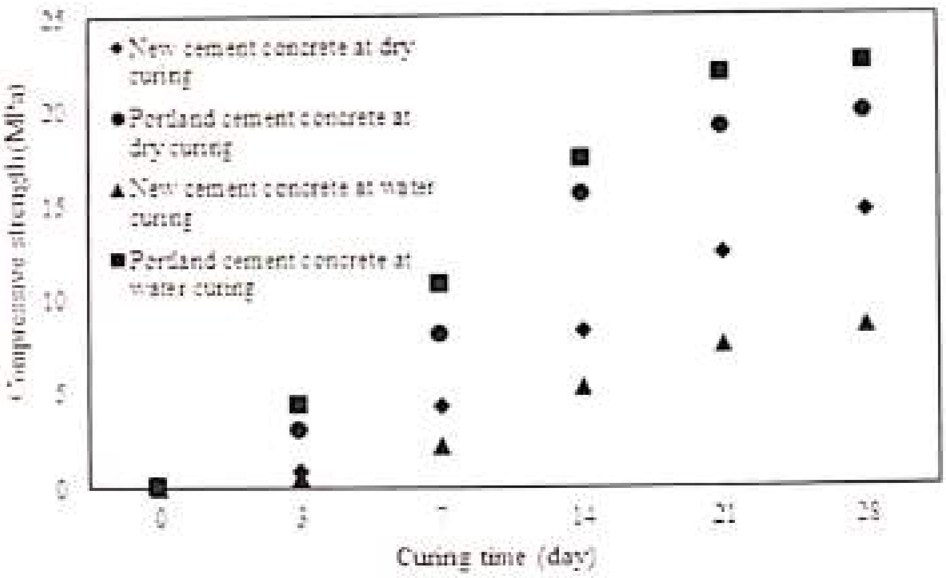

Figure 9. The lines of the test result of compressive strength of cylinder concretes of new cement concrete and of Portland cement concrete using dry curing and water curing methods

The compressive strength test of the cylinder concrete made of Portland cement by using water curing method results in 22.37 MPa, and it results in 19.71 MPa when the dry curing method is used. The compressive strength test for the cylinder concrete made of new cement using maintaining method of water curing results in 8.52 MPa, and it results in 14.52 MPa when the dry method is used. Although the compressive strength of new cement concrete is the lowest, the rate of compressive strength gain of new cement concrete is greater than that of Portland cement concrete.

Because the results of the new cement concrete and Portland cement concrete are very close to each other, it is concluded that the new cement and the new cement concrete could provide the demand of green binder and of green binder material for construction technology.

Moreover, it is necessary to review the chemical component of new cement on the compressive strength gain of new cement concrete. Since it contains much more oxides of calcium, silicon, iron, aluminum, magnesium, sodium, potassium, and sulfate, and lower gypsum content than that of Portland cement, new cement concrete demonstrates the slow compressive strength gain. This could be attributed to the lack of gypsum content in new cement concrete.

3.10 Splitting tensile strength

Figure 10 shows the graph comparisons of graphs between splitting tensile strengths of cylinder concrete made of new cement and of Portland cement. Results indicate that the test of material enables to endurance against force of splitting tensile. Additionally, the ratio of the splitting tensile strength of concrete shows to the compressive strength of concrete approximately 0.05 to 0.1.

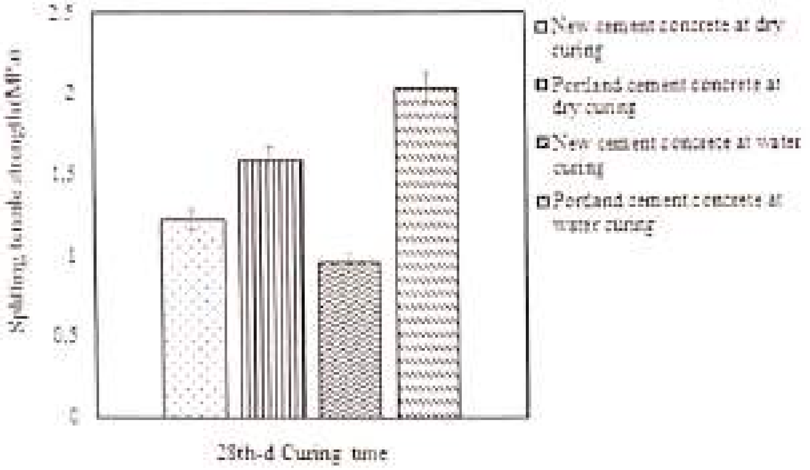

Figure 10. Splitting tensile strengths of concrete made of new cement and of Portland cement

Concrete made with Portland cement and cured in water has the highest splitting tensile strength. Water curing method results in 2.03 MPa splitting tensile strength for Portland cement concrete, while dry curing method leads to 1.59 MPa splitting tensile strength for Portland cement concrete.

Concrete made with new cement and dry cured shows a higher splitting tensile strength than those treated at water curing. The water curing method results in 0.96 MPa splitting tensile strength, while dry curing method leads to 1.22 MPa splitting tensile strength in concretes made of new cement. Figure 11 shows the failure patterns of concrete made with ordinary cement and the new cement at 28 days of curing. The failure pattern is similar for both types of cement.

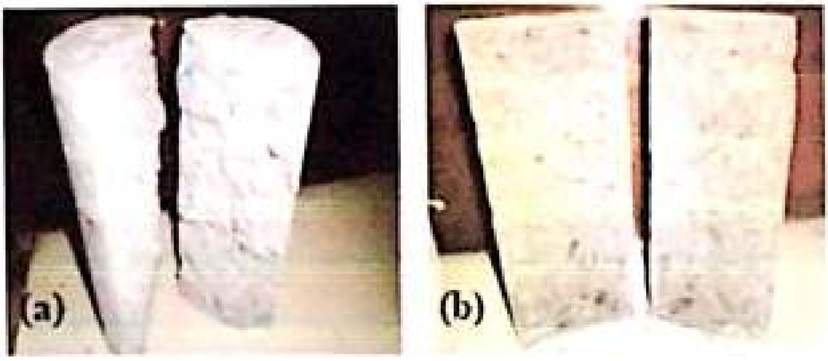

Figure 11. (a) Failure form of splitting tensile force at concrete cylinder made of new cement; and (b) failure form of splitting tensile force at concrete cylinder made of Portland cement.

Finally, despite the fact that the new cement is finer than the Portland cement, this is not a factor to affect the splitting tensile strength of new cement concrete positively. Curing conditions, wet curing and dry curing, are the most important contributing factors for the splitting tensile strength of new cement concrete. Because the splitting tensile strength results of new cement concrete and Portland cement concrete are very close to each other, it could be inferred that the new cement concrete could be a promising new green binder.

4. Conclusions

From the results of examination of fineness, density, consistency, setting-time, mineralogy, and chemical properties of new cement, there are similarities with the properties of Portland cement. This can be referred to the physical test results, XRF analysis, and XRD analysis of new cement.

The new cement is finer than Portland cement with a solid weight of 1200 m^2/kg, lighter than Portland cement which reaches 1250 m^2/kg. The specific gravity of Portland cement is 3.15 g/ml while the density of new cement is 3.05 g/ml. The initial setting time of Portland cement was carried out 90 min where the Vicat needle penetrated into the cement paste for 24 mm. The initial setting time of the new cement was also tested by the same method by penetrating 25 mm of cement for 105 min after the needle was removed. The final setting time of Portland cement is 180 min while the new cement reaches 225 min. Based on the results of slump, compressive strength, and splitting tensile strength, it can be concluded that new cement manufactured can be used for structural and non-structural work as well as for the installation of brick walls and for covering the walls with stucco. This demonstrated the ability of new cement to undergo chemical setting and binding of aggregate as a support material in a key process of construction work.

Additionally, the problem of waste and the effort of saving the environment from the accumulation of waste can be overcome wisely through this approach of experimental study, as this work has achieved to make new cement be an alternative binder material for construction industry, especially at dry curing condition.

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Availability of data and materials

The "Experimental and Numerical Research" data used to support the findings of this study are available from the corresponding author upon request.

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Declaration of interests

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Original Article

Development and assessment of cement and concrete made of the burning of quinary by-product

Muhammad Syarif [a], Mehmet Serkan Kırgız [b], André Gustavo de Sousa Galdino [c,*], M. Hesham El Naggar [d], Jahangir Mirza [e], Jamal Khatib [f], Said Kenai [g], Moncef Nehdi [d], John Kinuthia [h], Anwar Khitab [i], Carlos Thomas [j], Ravindran Gobinath [k], Muhammad Irfan Ul Hassan [l], Yan Kai Wu [m], Ahmed Ashteyat [n], Ahmed Soliman [o], Khairunisa Muthusamy [p], Thaarrini Janardhanan [q], Trinity Ama Tagbor [r], Tuan Anh Nguyen [s], Naraindas Bheel [t], Manoj A. Kumbhalkar [u], Chandra Sekhar Tiwary [v]

[a] Department of Architecture, Universitas Muhammadiyah Makassar, Jl. Sultan Alauddin No. 259, Gn. Sari, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90221, Indonesia
[b] Department of Architecture, Faculty of Engineering and Natural Sciences, Istanbul Sabahattin Zaim University, İstanbul 34303, Turkey
[c] Federal Institute of Education, Science and Technology of Espírito Santo, Av. Vitória, 1729, Jucutuquara, Vitória, ES 29040-780, Brazil
[d] Department of Civil and Environmental Engineering, Faculty of Engineering, Western University, 1151 Richmond St, London, ON N6A 3K7, Canada
[e] Faculty of Civil and Environmental Engineering, York University, 4700 Keele St, Toronto, ON M3J 1P3, Canada
[f] Department of Civil and Environmental Engineering, Faculty of Engineering, Beirut Arab University, Riad El Solh, 11072809 Beirut, Lebanon
[g] Geomaterials and Civil Engineering Laboratory, Civil Engineering Department, University of Blida 1, Route de Soumaa, Blida, Blida 09022, Algeria
[h] Advanced Materials Testing Centre (AMTeC), University of South Wales, Treforest Campus, Llantwit Rd, Pontypridd CF37 1DL, United Kingdom
[i] Department of Civil Engineering, Mirpur University of Science and Technology, Mirpur, AJK, Pakistan
[j] LADICIM (Laboratory of Materials Science and Engineering), University of Cantabria, 39005 Santander, Spain
[k] SR Engineering College, Warangal, Telangana 456, India
[l] University of Engineering and Technology, Civil Engineering Department, Lahore, Pakistan
[m] Shandong Provincial Key Laboratory of Civil Engineering Disaster Prevention and Mitigation, Qingdao 266590, China
[n] Civil Engineering Department, University of Jordan, Amman, Jordan
[o] Department of Building, Civil, and Environmental Engineering, Gina Cody School of Engineering and Computer Science, Concordia University, Montreal, Quebec, Canada
[p] Faculty of Civil Engineering Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Pahang, Malaysia

* Corresponding author.
E-mail address: andregsg@ifes.edu.br (A.G.S. Galdino).
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Department of Civil Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, Tamilnadu, India
Council for Scientific and Industrial Research-Institute of Industrial Research, P. O. Box LG 576 Legon, Accra, Ghana
Institute for Tropical Technology, Vietnam Academy of Science and Technology, Viet Nam
Department of Civil and Environmental Engineering, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, Tronoh, Perak 31750, Malaysia
Department of Mechanical Engineering, JSPM Narhe Technical Campus, Pune 411041, India
School of Nano Science and Technology, Indian Institute of Technology, Kharagpur, West Bengal 721302, India

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ABSTRACT

The aim of this study is to evaluate the usability of new cement (NC) made by the burning of quinary by-product to make commercial binders. Chemical analysis of the by-products and NC as well as X-ray diffraction (XRD) analysis of NC, fineness, density, consistency, and setting time of NC paste, and slump in addition to compressive strength (CS) and splitting tensile strength (STS) of NC concrete (NCC) were conducted. The results suggested that chemical composition of by-products is suitable to make NC binder. The NC contains Ca_3SiO_5, Ca_2SiO_4, $Ca_3Al_2O_6$, and $Ca_4Al_2FeO_{10}$. The particles passing through the 200 μm Sieve were 56% compared with 52% for Portland cement (PC). The density of the of NC was similar to that of PC. The NC needed 48% more water than PC for normal consistency. The initial and final setting-time of NC was 105 min and 225 min respectively which is much higher than that of PC (15 and 45 min). The slump, compressive strength and splitting tensile strength were slightly lower for concrete containing NC compared with that pf PC concrete. Although the CS and STS of NCC are the lowest, the rate of the CS and STS gain of NCC is greater than that of PCC. It was concluded that NC is a viable alternative to PC for the production of greener concrete.

1. Introduction

In 2020, the World Bank reported that 2.01 billion tons of the municipal solid waste (MSW) are generated annually in the world, and approximately 230 million tons of it was burned. It is expected that the global municipal solid waste will grow to 3.46 billion tons by 2050 [1]. Considering the fact related to the municipal solid waste, coal bottom ash is another waste material generated by power plants. The annual production of coal bottom ash (CBA) is 25 million tons of coal bottom ash (CBA) in India [2], 14 million tons in US, 4 million tons in Europe [3] and about 1.7 million tons in Malaysia [4] which creates environmental problems for the global society. The majority of CBA is used as landfill material and there is no effort to transform it into construction material or other useful products. This situation is not different for pulverized fuel ash (PFA) where 360 million tons of PFA are generated every year and most of the waste (216 million tons) are still stored on the land. According to the United States Environmental Protection Agency (EPA), the use of PFA for landfilling and for construction materials is not harmful to ground water resources [5]. Therefore, using PFA in concrete can reduce the amount sent to landfill and generate income for the producer which is currently between US$ 20 and 45 per ton [6]. In Europe, according to the European Union (EU) report presented in 2011, the amount of construction and demolition waste (CDW) generated annually in Europe is approximately 1 billion tons, including waste calcined clay brick remnant (WCCBR) [7]. Conventional method to overcome WCCBR is through dumping in landfills which is also expensive. The cost of recycling of one ton of CDW, concrete, brick, and masonry remnants, is about $21/ton, whilst the cost of landfilling is about $136/ton [8]. Mediterranean soil, and rock contain high amount of lime component which is essential for cement production.

Additionally, cement manufacturing system releases large amounts of CO_2 into the atmosphere through combustion of fossil fuels and the decomposition of calcium carbonates. This release leads to approximately 7% of total green-house gas (G-HG) emission in the world. Reduction of CO_2 emission due to cement manufacturing can be achieved through: (a) minimizing clinker quantity and increasing the supplementary cementitious materials (SCM) quantity; (b) manufacturing of innovative cement; (c) developing existing cement plants with renewable energy resources, to create new alternative fuels (e.g., bio-mass and waste materials in the burning steps) and (d) making capturing of CO_2 emission during cement manufacturing and its reuse in the production of cement and cement-based material [9].

Supplementary cementitious materials (SCM) can be used to minimize the clinker quantity. These include the use of rice husk ash, palm oil fuel ash, bagasse ash, blast furnace slag, coal fly ash, steel slag and silica fume [10–17]. Using more than one type of waste as supplementary cement materials is not very common. Kikuchi [18] used solid waste incineration

Fig. 1 – Various wastes and natural raw materials, and new clinker and cement manufactured.

ash for the production of cement and recommended the use of approximately 50% of this waste can used as raw materials. This process of manufacturing does not lead to secondary pollution in air, earth and water. In 2018 Joseph et al. [19] reported that huge quantities of the municipal solid waste (MSW) are generated annually and most of it is sent to landfill. Therefore, using MSW in the manufacture of cement will reduce the quantity sent to landfill and the associated pollution.

In 2014, the European Cement Research Academy [20] reported that the compressive strength of grout containing cement manufactured using kaolinite clay as one of raw materials was higher than that using traditional cement. Apart from the burning process to dispose the waste, another significant study was carried out by Ferraro et al. [21] to produce lightweight aggregate with waste and to minimize risks related to disposal of waste. Analysis of cold-bonding method gave a broad outcome on the treatment and reuse of waste materials productively. Additionally, it presented an important way to decide optimization of waste usefully for both producers and researchers who would like to work on the cold-bonding method.

BS EN 197-1 standard [22] specifies limits for the oxide composition of new cements; the $CaO-SiO_2$ ratio (by mass) should not be lower than 2 and the magnesium oxide and the loss on ignition should not be greater than 5%. However, there has no standard limit for heavy metal leaching for cement and cement-based materials [22].

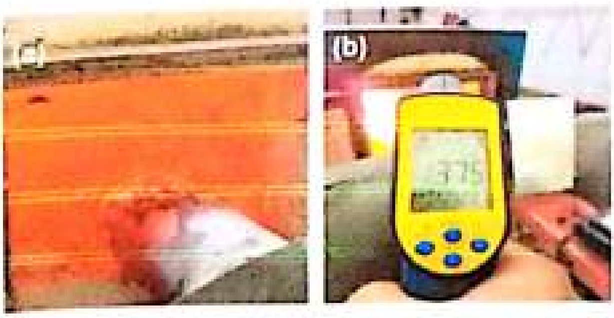

Fig. 2 – The clinkerization from the waste concentrate used in the study: (a) furnace; (b) process temperature.

This paper examines the properties of an innovative cement made of more than one type of by-products. The raw materials used for the production of clinker are; pulverized fuel ash, bottom ash, calcined clay waste, Mediterranean soil and household waste ash. To the authors knowledge, there is no research combining more than two waste materials mentioned above in the production of a new cement. The properties of the new cement included fineness, density, consistency, setting-time, chemical component, mineralogy of new cement, and workability, compressive strength, and splitting tensile strength.

2. Materials and methods

2.1. *Research procedures*

The study was planned in four stages. First stage is related to measure chemical components of by-products (coal bottom ash, coal fly ash, household waste, Mediterranean soil, calcined clay) according to ASTM C 114-18 [23]. This stage is called as description stage of by-products. Fig. 1 illustrates various wastes and natural raw materials, and new clinker and cement manufactured.

Second stage deals with manufacturing new cement with burning the farina which was prepared with quinary by-product. New cement was called as organic cement.

Third stage scope is measurement of new cement specifications, such as chemical components, water demand, fineness, density, setting-time, mineralogy with X-ray powder diffraction (XRD). The specifications were determined according to ASTM C 114-18 [23], ASTM C 187-04 [24], ASTM C 204-18e1 [25], ASTM C 188-95 [26], ASTM C 191-19 [27], ASTM C 1365-18 [28].

Fourth stage deals with manufacturing concrete specimens made of new organic cement and measurement of their slump, compressive strength, and splitting tensile strength.

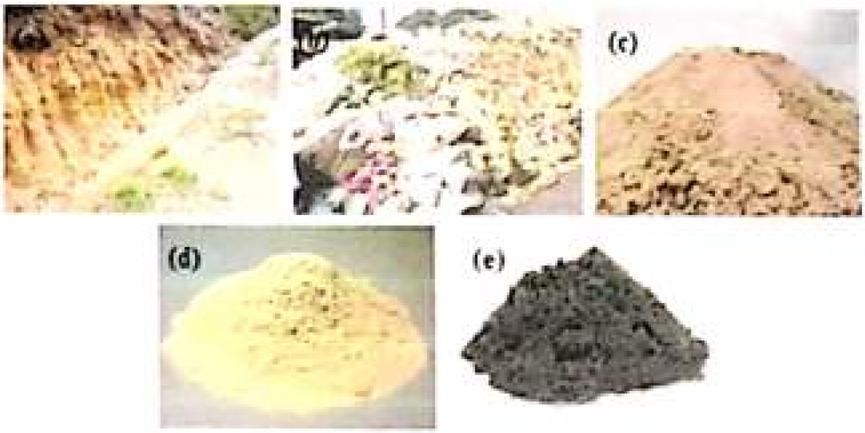

Fig. 3 – The cement raw material before the combustion process to become the cement concentrate: (a) the Mediterranean soil; (b) the household waste; (c) the calcined clay; (d) the pulverized fuel ash; and (e) the bottom ash.

Table 1 – Percentage of new cement forming.

No	Material source	Main composition (Major)			Additional chemical elements (minor)
		Major chemical elements	Material source	Material used elements	
1.	Mediterranean Soil/S	CaO	60.93	54	SiO_2, Al_2O_3, Fe_2O_3, MgO, SO_3, Na_2O, K_2O
2.	Clay/I	SiO_2	30.63	10	SiO_2, Al_2O_3, Fe_2O_3, CaO, Na_2O, K_2O, MgO, SO_3
3.	Fly Ash/N	SiO_2	22.14	4	Al_2O_3, CaO, Fe_2O_3, SO_3, Na_2O, K_2O, MnO, MgO, TiO_2
4.	Bottom Ash/A	SiO_2	15.20	4	CaO, Al_2O_3, Fe_2O_3, MgO, K_2O, Na_2O
5.	Household waste/R	SiO_2	46.65	28	CaO, Al_2O_3, Fe_2O_3, MgO, K_2O, TiO_2, Na_2O, P_2O_5

The compressive strength measurement was performed at 3, 7, 14, 21, and 28 days, and the splitting tensile strength measurement was carried out at 28 days. The properties were determined according to ASTM C 143/C 143M-20 [29], ASTM C 39/C 39M-21 [30], and ASTM C 496/C 496M-17 [31].

The empirical Eq. (1) was used with the by-products mentioned previously to obtain farina.

$$\sum R_{ij} = \frac{\sum S + \sum I \sum N \sum A \sum R}{100} \quad (1)$$

where $\sum R_{ij}$ is the new cement concentrate (kg); $\sum S$ is the Mediterranean soil concentrate (%); $\sum I$ is the calcined clay waste concentrate (%); $\sum N$ is the household waste concentrate (%); $\sum A$ is the fly ash concentrate (%); and $\sum R$ is the bottom ash concentrate (%).

To manufacture new cement clinker, the farina (combination of Mediterranean soil, household by-product, calcined clay by-product, fuel ash, and bottom ash) prepared by Eq. (1) was burned at 1375 °C, maintained for four hours and cooled in the laboratory. This new clinker was mixed with 2 wt% gypsum and ground to make the new cement. Fig. 2 shows the clinkerization from the waste concentrate used in the study and Fig. 3 shows the cement raw material before the combustion process to become the cement concentrate.

The percentage of the main ingredients used in the new cement forming is shown in Table 1 below.

2.2. Methods

2.2.1. Chemical component test of by-products and new cement

Chemical composition of Mediterranean soil, household by-product, calcined clay by-product, fuel ash, and bottom ash was determined according to ASTM C114-18 [32] standard,

Table 2 – Details of the concrete mixes.

Types of material	w/c	Proportion of materials (kg/m³)				Target slump height planned (mm)
		Water	Cement	Materials		
				FA[a]	CA[b]	
New cement concrete	0.52	195	375	538	1232	120
Portland cement concrete	0.52	195	375	538	1232	120

[a] Fine aggregates (FA) ≤ 2.5 mm.
[b] Coarse aggregates (CA) ≤ 20 mm.

Table 3 – Chemical composition of the by-products used in the manufacturing of new cement.

Chemical compound	Chemical composition (%)				
	Mediterranean soil	Household waste	Calcined clay	Fly ash	Bottom ash
SiO_2	60.93	46.65	30.63	22.14	15.2
Al_2O_3	0.44	2.28	3.41	3.84	2.99
Fe_2O_3	0.15	0.18	0.20	0.20	0.20
CaO	19.35	11.09	0.51	6.87	1.41
SO_3	1.66	1.01	0.36	0.89	0.15
Na_2O	0.01	2.24	0.01	0.37	1.03
K_2O	0.09	11.56	0.23	0.58	0.17
MgO	0.018	0.02	0.02	0.03	0.02
P_2O_5	N/A	0.47	N/A	N/A	N/A
LOI	N/A	N/A	N/A	N/A	N/A

The N/A stands for the "Not available" and the LOI stands for the "Loss on ignition" in the chemistry of cement.

which is known the wet chemical analysis method. Chemical component of the new cement was determined by using the Energy Dispersive X-Ray Fluorescence method.

2.2.2. *XRD analysis*

Mineralogy of new cement was conducted by XRD analysis according to ASTM C1365-18 [20]. Equations of Bogue calculation and being created of such Bogue chemical compounds as the C_3S, the C_2S, the C_3A and the C_4AF led to some discussion related to the strength gain mechanism of cement-based materials. In the light of the discussion, some comprehensive studies, which used X-ray powder diffraction (XRD), investigate mineral compound of new cement according to ASTM C1365-18 [28]. Bragg equation (Eq. (2)) was used to calculate diffraction angle of X-rays dispersed from sample.

$$n\lambda = 2d \cdot \sin\theta \tag{2}$$

where the symbol of θ is a diffraction angle of material, the symbol of n is a constant, the symbol of λ is a wavelength of the X-ray scattered from new cement, and the symbol of d is a distance between two adjacent parallel lattice planes in the inner crystal structure.

2.2.3. Fineness test

For establishing the size of cement particle firstly, sieve analysis was conducted with a 200-mesh sieve. In accordance with ASTM C 204-18e1 standard [23], fineness of new cement was determined with the following processes: (1) get some specimen from new cement, (2) scrub the specimen to prevent lumps, (3) have a weigh of 100 g specimen and make it note as (W_1), (4) put the 100 g of specimen on the 200 mesh sieve, and make its lid covered, (5) vibrate the sieve for fifteen (min) (6) have a weigh of residue left on the 200 mesh sieve, and make it note as (W_2), (7) make the left percentage of weight of cement calculate with Eq. (3) and note as (W_3). The test was repeated the mentioned processes with three different specimens of new cement. The presented fineness result is the average quantity of new cement as descriptive statistic.

$$W_3 = \frac{W_2}{W_1} \times 100 \tag{3}$$

2.2.4. Density test

Density of new cement and Portland cement was measured according to ASTM C 188-95 standard [26]. The following processes were employed in the test; (1) have a weigh of clean and dry the Le Chatelier flask and make it record as (W_1), (2) fill the new cement specimen up to half of the flask (approximately 50 mg), (3) have a weigh of the Le Chatelier flask along with the specimen and make it note as (W_2), (4) add kerosene into the flask until the flask is almost full of half, (5) make the flask blend thoroughly to remove air entrapped, (6) continue the blending of flask and add kerosene until the flask is filled

Table 4 – Chemical component of the new cement, its comparison with Portland cement, and the limits in chemical component of hydraulic binder to BS EN 197-1:2011 standard [22].

Chemical component	New cement (%)	Portland cement (%)	The limits in chemical component of hydraulic binder to BS EN 197-1:2011 (%) [14]
Alite (C_3S)	69.9	50–70	–
Belite (C_2S)	7.3	15–30	–
Tri calcium aluminate (C_3A)	10.3	5–10	–
Brownmillerite (C_4AF)	3.1	5–15	–
Silicon oxide (SiO_2)	21.29	20.6	–
Aluminum oxide (Al_2O_3)	7.86	5.07	–
Iron oxide (Fe_2O_3)	4.4	2.9	–
Calcium oxide (CaO)	68.43	63.9	–
Sulfate oxide (SO_4)	3.2	2.53	≤ 5
Sodium + Potassium oxide $Na_2O + K_2O$	1.58	0.88	≤ 2
Magnesium oxide (MgO)	4.8	1.53	≤ 5
Loss on ignition (LOI)	1.03	1.58	≤ 5

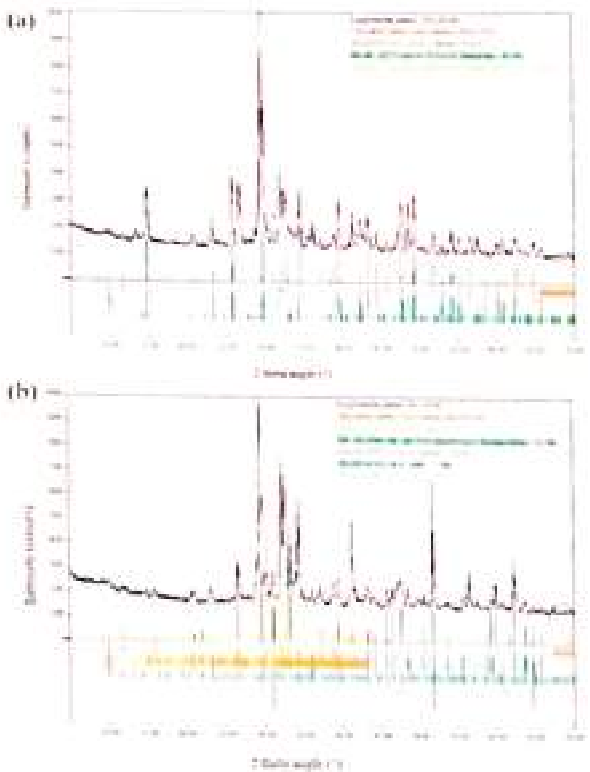

Fig. 4 – XRD diffractograms of: (a) Portland cement; and (b) new cement.

up the graduated mark, (7) make the flask outside dry and get a weigh of flask and note it as (W_3), (8) discharge the flask and make it dry, (9) fill the kerosene into the flask with the graduated mark, (10) make the flask outside dry and have a weigh of the flask with kerosene and note it as (W_4). The density of new cement and Portland cement was calculated along with the following Eq. (4) as will be seen below.

$$\gamma = \frac{(W_3 - W_1)}{[(W_2 - W_1) - (W_3 - W_4)] \times 0.79} \quad (4)$$

In Eq. (4), γ is the density of cement as g/cm^3 and the density of kerosene is 0.79 g/cm^3 was used.

2.2.5. Consistency test

Consistency test of new cement paste and Portland cement paste was conducted to establish the need of water to reach the normal consistency of cement paste. The consistency of new cement paste and Portland cement paste was performed according to ASTM C 187-04 standard [24]. Following process summarizes the test; (1) have a weigh of 400 g specimen and put it in a bowl along with lid (2) make the specimen prevented humidity, (3) put 28% of water by mass of cement specimen and blend it, (4) continue blending cement paste for 3–5 min, (5) fill up the cement paste in the Vicat mold, (6) make the plunger touched the surface of cement paste in the Vicat mold, (7) let the plunger fall to sink into the test mold, (8) make the penetration depth of the plunger from the bottom of mold record, as indicated on the scale of Vicat, (9) repeat the same test along with new paste which was made of different percentages of water until the penetration depth of plunger reaches a degree among 5–7 mm. Three different specimens of cement paste

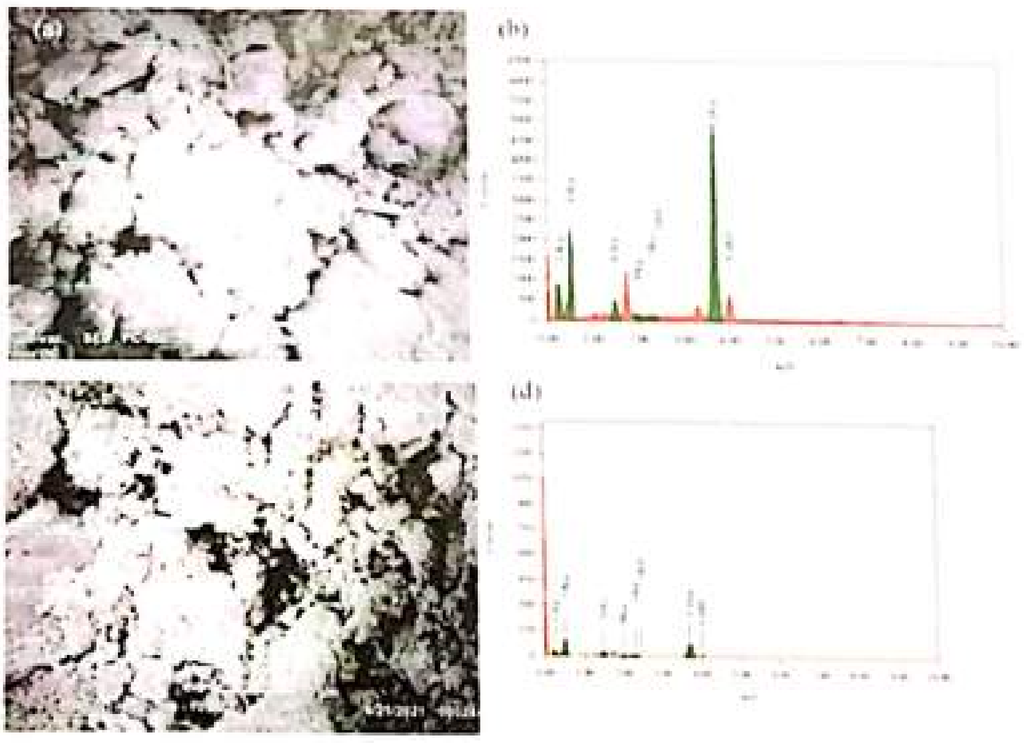

Fig. 5 – (a) New cement SEM; (b) New cement EDX; (c) Portland cement SEM; (d) Portland cement EDX.

Table 5 – EDX results of new organic cement and Portland cement pastes.

Specimen	Chemical composition (%)					
	Ca	O	Al	C	P	S
New organic cement paste	66.81	29.04	2.18	1.67	0.17	0.13
Portland cement paste	58.07	32.05	6.97	1.11	0.08	1.72

were used to repeat the processes of consistency mentioned above, to make it recorded as an average result of consistency.

2.2.6. Setting-time test

According to ASTM C 191-19 standard [27], the setting-time of new cement paste and Portland cement paste was performed as follows: (1) have a weigh of 400 g of specimen from cement (2) make the specimen placed in a bowl along with lid to prevent humidity, (3) put three fifths milliliters of water by mass of cement in the bowl, (4) blend the water and cement specimen, (5) fill the cement paste up Vicat mold, (6) make the plunger of Vicat touched on the surface of cement paste, (7) let the plunger drop to sink into the test mold, (8) make the penetration depth of the plunger from the bottom of mold recorded, as indicated on the scale of Vicat, (9) do again the dropping of plunger at different places on the surface of cement paste until the plunger ceases penetrating 25 ± 2 mm from the bottom of the Vicat mold. At 5 ± 2 mm penetration depth, it is the time for the initial time of setting of the cement paste, (10) record the time for the final setting-time once the plunger is not sinking 0 ± 2 mm from the upper surface of cement paste in the Vicat mold.

2.2.7. Slump test

Slump of concrete was determined according to ASTM C 143/C 143M-20 standard [23]. To obtain the required workability, a mix design was made as shown in Table 2.

2.2.8. Compressive strength test

Compressive strength of concrete was determined according to ASTM C39/C39M-21 standard [30]. The compressive strength of cylinder concrete was calculated according to Eq. (5).

$$\sigma = \frac{F}{A} \quad (5)$$

where the σ is the compressive strength of concrete (MPa), F is the compressive force in failure (N), and A is the cross-sectional field of concrete used (mm^2).

2.2.9. Splitting tensile strength test

Splitting tensile strength of concrete was determined according to ASTM C496/C496M-17 standard [31]. The splitting tensile strength was calculated according to Eq. (6).

$$f_{ct} = \frac{2 \times P}{L \times D} \quad (6)$$

where the f_{ct} is the splitting tensile strength (MPa), P is the maximum force in failure (N), L is the length of concrete specimen (mm), and D is the diameter of concrete specimen (mm).

Table 6 – The fineness of new cement and Portland cement determined in the experimental study.

Type of fineness measure	Types of material	
	New cement	Portland cement
200 mesh sieve passing (%)	56	52
Specific surface area (m^2/kg)	1200	1250

3. Results and discussions

3.1. Chemical composition of by-products

The wet analysis method was used to determine the chemical composition of the binder. This includes the by-product materials such as Mediterranean soil, house hold waste, calcined clay, fly ash and bottom ash. Table 3 shows the chemical composition results of various by-products used in the manufacturing of new cement.

If it is necessary, the technique which includes separation and isolation is applied to the specimen. The methods of stoichiometric, such as the gravimetric method and the volumetric method, are used in the wet chemical analysis to get the quantitative elements and chemical compounds of the specimen. There are two wet chemical analysis types. The first is the qualitative analysis that establishes which elements are in the specimen, and the second is the quantitative analysis which gives the quantity of elements in the specimen. Almalkawi et al. in 2019 [32] recommended that the use of industrial by-product in geopolymer binder as a green construction material is beneficial and used the wet analysis method for the determination of the chemical components. The study's results proved that ternary blend of by-products could be used to make hydraulic geopolymer binder along with the strength and the upcycling targeted.

Another study on by-product packing glass by bottle, which is similar to Almalkawi et al. was conducted by Ibrahim and Meawad in 2018 [33] and the authors also used the wet chemistry method for the chemical composition of the by-products. Their results revealed that the powder of by-product which was obtained from uncolored glass, green glass, and brown glass is available to make supplementary cementitious materials, and their ions are responsible for their color do not have an effect on the binder properties negatively. ASTM C618-19 standard [34] identified that fly ash pozzolan used has to include more than 70 wt% of silicon oxide (SiO_2) + aluminum oxide (Al_2O_3) + iron oxide (Fe_2O_3) in total. In the current study, the content of SiO_2, Al_2O_3, Fe_2O_3 and calcium oxide (CaO) suggests valuable chemical component and potential for new hydraulic binder, and will let the new cement develop strength gain slowly.

There are other studies that show the necessity of the chemical component identification for new material and conventional binder. One of them is an important study reported by Ruiz-Sanchez et al. in 2019 [33], entitled "Waste marble dust: An interesting residue to produce cement". This study made six clinker types through by-product of marble powder. In order to better examine the chemistry of new binder, they performed the wet chemical analysis on the binder. The results revealed that the chemical component of by-product of marble powder consists of the major presence of CaO, and its physico-chemical analysis confirmed its feasibility, pureness, and cleanness. Additionally, another work conducted by Kirgiz [34] also demonstrated that chemical component of cement manufacturing with burning marble powder and brick powder is essential to decide on this method's usefulness. The works mentioned above support the current work in term of chemical component necessity once new hydraulic cement is manufactured.

3.2. Chemical component

Table 4 shows chemical component of new cement, its comparison with Portland cement, and the limits in chemical component of hydraulic binder according to BS EN 197-1:2011 standard [22]. Chemical component performed by XRF was identified and enumerated with the X-ray radiation reflecting from the material with photoelectric way. The way of photoelectric catches the gamma radiation of X-ray because the electrons are spread from atoms in the specimen through high-energy collisions.

ASTM C 114-18 standard [35] was known as the guideline for this test because the reference is a normative reference which is considerably relevant to the process of chemical component testing of cement. In Table 3, new cement shows that all the limits presented by BS EN 197-1:2011 standard [22] are satisfied. The major ingredient of new cement consists of, as shown in Table 3, the calcium and silicon oxides (greater than 89.7% in total). This quantity of such oxides makes new cement get hydraulic binder properties. Moreover, because of surplus of C_3S, new hydraulic cement can be sorted as an alite along with minor content of belite, tri calcium aluminate, and brownmillerite.

3.3. Microstructural analyses

Fig. 4 shows the comparison of XRD results between the new cement and Portland cement. The X-ray diffraction test result of the new cement is, then, analyzed by searching and matching, like being in references [37–40].

Additionally, to the result of the searching and matching, it has been concluded that the chemical component of new cement shows similar components as Portland cement. Of all the chemical component presents in the Portland cement, the most important chemical components are alite (Ca_3SiO_5; C_3S stands for tri-calcium silicate), belite (Ca_2SiO_5; C_2S stands for di-calcium silicate), aluminate ($Ca_3Al_2O_6$; C_3A stands for tri-calcium aluminate, and ferrite ($Ca_4Al_2FeO_{10}$; C_4AF stands for tetra-calcium alumina ferrite). The four chemical components were obtained for the new cement after its combustion at high and controlled temperature at 1375 °C.

SEM/EDX analyses of new cement paste made of the burning of pulverized fuel ash, pulverized bottom ash, household waste, Mediterranean soil, and calcined clay waste are shown in Fig. 5.

The SEM micrographs in Fig. 5 which were taken from paste specimen containing new cement shows the ettringite crystals which were spread into calcium hydroxide. Ettringite is formed in the early age of paste to reduce the flash setting of cement, nevertheless, its meaning is that the hydration of the paste mixing had not been completed, which will lead to an expansion. Therefore, it weakens the interfacial transition zone in cement-based materials. It was observed in hydration of new cement paste, angular cement grains were surrounded by radiating amorph of calcium hydroxide (CH) which resemble the pattern of CH in ordinary cement paste. Randomly oriented portlandite (CH) crystals and prismatic ettringite crystals were widely dispersed throughout the paste. Table 5 shows the chemical elements of new cement paste and ordinary cement paste which were observed in SEM/EDX machine.

However, in the new cement paste, SEM found out that the ettringite prisms were covered with amorphous layered CH hydration products. Matrix phase is mainly composed of short radicular outgrowths of CHs around cement grains and needle-shaped ettringite crystals (Fig. 5(a)). Microstructure of hydrated new cement paste was presented by amorphous gel filling spaces between hydrated particles. Moreover, the new cement pastes layered accumulations of the CH crystals which are approximately 10–12 μm in width are intermingled throughout the paste (Fig. 5(a)). There is a visible densification around new cement grain, leading to formation of additional

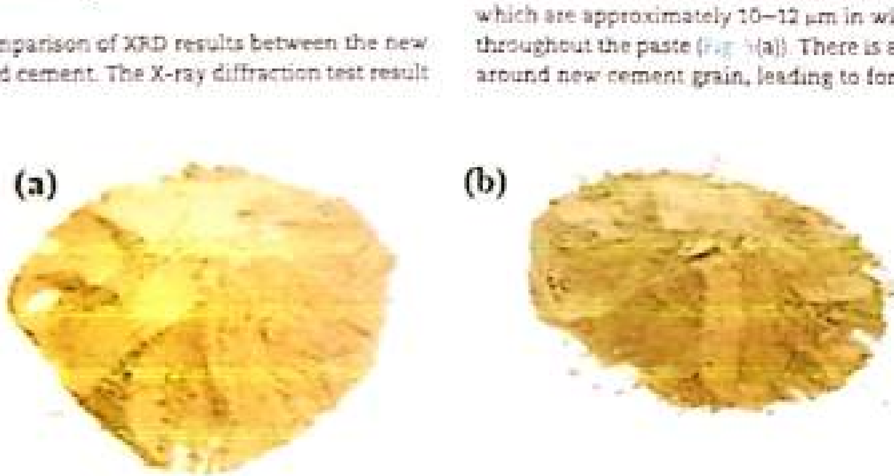

Fig. 6 – A process of measuring the fineness and the density of cement: (a) new cement; and (b) the Portland cement that is used as a comparator in testing the physical properties.

Table 7 – Normal consistency results of new cement paste and Portland cement paste.

Type of binder and mixing material quantity		Test of consistency			Average results of consistency (%)
		Specimen I	Specimen II	Specimen III	
Portland cement	Cement (g)	500	500	500	25
	Water (ml)	128	125	122	
New cement	Cement (g)	500	500	500	37
	Water (ml)	175	180	200	

C–S–H for later age. Observation of new cement paste demonstrated that the CH phase is found to be richer than C–S–H gel.

Fig. 5(c) and (d) shows SEM and EDX analysis of ordinary Portland cement paste respectively. The ordinary cement paste contains calcium hydroxide (CH), ettringite needles, CSH gel and calcium alumina hydrate (C–A–H).

Table 5 presents EDX results of both new organic cement and Portland cement pastes. From the comparison of chemical elements of new organic cement paste and ordinary Portland cement paste, it can be deduced that their results are similar. This means that both SEM/EDX; wet chemical; and XRD results support the properties of new organic cement and Portland cement pastes.

3.4. Fineness

The more fineness is the more cement particles participate in hydration since cement starts hydration process from surface to inside in the cement-based materials. Thus, hydration performance is related to the fineness of cement, and for a rapid gain of strength, the more fineness is a necessity. On the other hand, the greater fineness is the more cost of grinding process is for cement. Moreover, the effect of more fineness on such other properties as slump of fresh concrete, gain of strength and need of gypsum have to be taken into account. Fineness is an important property of binder, and it is necessary to make the fineness be determined with sieve method and specific surface method in m^2/kg according to the rules of BS and ASTM standards. The air permeability method, which makes the pressure drop once dry air flows at a constant velocity through a bed of cement known porosity and thickness determines the specific surface of cement. In 2020, Kumar and Nath [41] suggested that the finer cement, the better are its properties and the better is the development of its

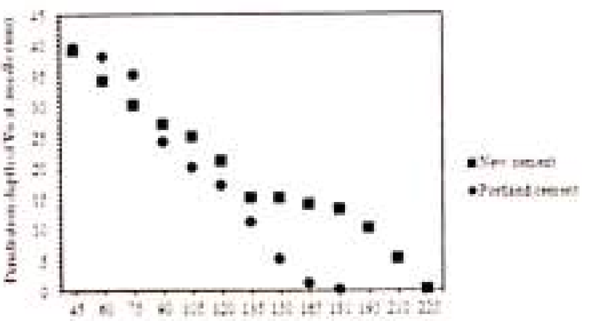

Fig. 7 – Initial and final setting time of new cement and Portland cement determined.

microstructure. Kan et al. in 2019 [42], explained the importance of fineness property for cement-based binders. The fineness of new cement and Portland cement determined was given in Table 6.

The quantity of fineness of new cement is 56% for the 200-mesh sieve passing and 1200 m^2/kg for specific surface area while the quantity of fineness of Portland cement is 52% for the 200-mesh sieve passing and 1250 m^2/kg for specific surface area. The smoother cement is the greater specific surface area is for cement particle. An increase in fineness will accelerate the hydration process with more water demand than that of normal hydration process of Portland cement. Image of new cement and Portland cement is presented in Fig. 6.

In concrete mixing, water-to-cement ratio is calculated with water mass/cement mass and usually shorten as w/c. The water-to-cement ratio has a strong effect on the strength gain of concrete. For instance, in a concrete mixture which strength gain was targeted, increase in w/c will decrease the gain of strength at all ages, and decrease in w/c will increase the gain of strength at all ages [43]. In 2019 Ghasemi et al. recommended a relationship between the specific surface are of mortar constituent and its flow [44]. Its results revealed that the demand of water in cement-based material is related to the specific surface area of mixture constituents. Estimation of the specific surface area depends on accounting of angularity of particle while content of water and thickness of paste film are essential for estimating the fluidity [44].

3.5. Density

The adaptation of density of cement in connection with vibration and plasticizer could enable more workability for concrete [43]. Comprehensive works, which are taken into account to reach out the targeted final properties of concrete, were conducted on the bulk density of cement as plenty of many theoretical models recommended to estimate the bulk density of cement [45–48]. The bulk density of Portland cement is 3.15 g/ml while the density of new cement is 3.05 g/ml as will be observed at the current research work. In this case, the ASTM C 188-95 [26] standard formulated the bulk density of cement, and it is valid. Apparent density of fresh concrete with new cement is 2081 kg/m^3 and its dry density is 2032 kg/m^3. The both are lower than that of Portland cement concrete (2525 kg/m^3).

Additionally, these estimation models are depended on the bulk density curve optimization, vibration of cement-based material, and the quantity of ingredient calculation. Firstly, choosing of concrete and cement-based material has to consider the void of side edge in formwork for construction element, such as column, beam, and floor, so that the void of rust ratio could be filled concrete up. Secondly, the bulk density of materials used in the mixture needs to be known. Lastly, the modeling of bulk density relates to the theoretical density of concrete and cement-based material mixture because this theoretical density could be computed mathematically by determining the bulk density of cement which has different mean size of particle as well [46,49].

3.6. Consistency

Table 7 shows the result of normal consistency test for the new cement paste and Portland cement paste. The test of normal consistency is referred to ASTM C 187-04 [74].

The importance of consistency test stems from the fact that when water is mixed with cement, its hydration process starts. Surplus addition of water in cement leads up to an increase in water-to-cement ratio, and the increased water reduces the strength of cement paste after it hardens. If less water is added than required, the cement paste composite is not properly hydrated, and the insufficient water content leads up to the loss on the strength, especially the compressive strength. Water has an influence on the workability, strength, shrinkage, and durability of concrete. Normal consistency formed in new cement is a need of 37% water by mass of cement while the need is of 30% water by mass of Portland cement.

3.7. Setting-time

Fig. 7 shows initial and final setting time of new cement and Portland cement. As new cement contains 2% gypsum and 98% new clinker, which was prepared by burning compound of Mediterranean soil, calcined clay, bottom ash, fuel ash, and household waste. The new cement hardens slower than Portland cement, as shown in both initial set and final set test results. That setting process of new cement indicates that if it is necessary to harden rapidly, the gypsum percent within the new cement has to be increased.

The ASTM C 191-19 [27] defines the required setting-time that it starts when water contacts with cement and continues before chemical reactions cease, even if cement is placed under the water. According to ASTM C 191-19 standard [27], initial setting-time of cement should not start before 75 min. Since the new cement started initial setting-time at 105 min and Portland cement started initial setting-time at 90 min, both new cement and Portland cement obtains the standard rule on initial setting-time according to ASTM C 191-19 standard [27].

At initial setting-time, new cement includes 37% water content while Portland cement contains 25% water content. The more water is the lower consistency is for the new cement and Portland cement. The final setting time of Portland cement is at 180 min, while final setting time of the new cement is at 225 min. Both final setting-time of new cement and of Portland cement enable to obtain standard rule for final setting-time of concrete that it should not be greater than ten hours. As known from literature, C_3A and C_3S starts the setting-time of Portland cement. After that, C_2S hardens the Portland cement gradually. Lastly, C_4AF participates in the setting-time of Portland cement.

As seen in Table 4, new cement has 55% greater aluminum oxide, 51% greater iron oxide, 3% greater silicon oxide, 7% greater calcium oxide, 24% greater sulfate oxide, and 313% greater magnesium oxide than that of Portland cement. Gypsum content varies between 3% and 5% in the Portland cement. New cement contained 2% gypsum, instead. The difference in chemical component and gypsum content

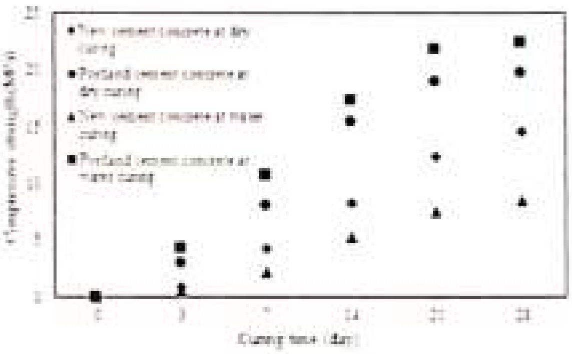

Fig. 9 – The lines of the test result of compressive strength of cylinder concretes of new cement concrete and of Portland cement concrete using dry curing and water curing methods.

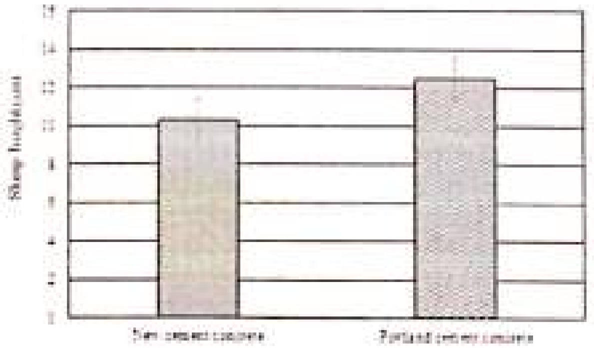

Fig. 8 – Slump heights of new cement concrete and Portland cement concrete with water-to-cement ratio 0.52 and their standard errors.

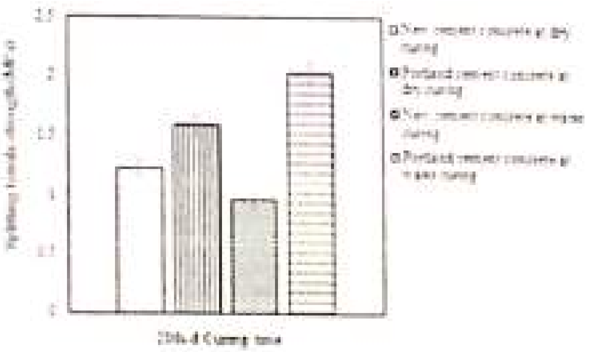

Fig. 10 – Splitting tensile strengths of concrete made of new cement and of Portland cement.

among new cement and Portland cement led to a difference in their setting-times. Apart from rapid and false setting-time and crystalline structure of cement paste, formation of film layer in the surface of cement particles and coagulation of chemical component of cement are two important factors which develop the setting-time. It is clear that the more aluminum oxide component is the more retarding of the setting time of new cement is because it leads to an increase in heat during stiffness process of the new cement. Its setting-time could be accelerated with an increase in gypsum content in new cement. Nevertheless, the initial and final setting-time is suitable for the new cement because it obtains the limit of setting-time which was specified by the BS EN 197-1:2011 standard [22].

3.8. Workability

Slump test of concrete was measured according to the rules of ASTM C 143/C 143M-20 standard method [29]. Slump is the oldest and the most widely known property for monitoring the workability of concrete. Workability of fresh concrete is related to the flow and w/c at microstructure field between cement paste and aggregate during preparing, transport, vibrating, and putting concrete into formwork. Considering the concrete mix, three different types of slump can happen: true slump, shear slump, and collapse slump. True slump depends on leveling of the concrete mass with keeping integrity.

The lack of cohesion in concrete constituent points the shear slump which leads to segregation. The collapse slump is the most dangerous one among the all. It usually points a lean, harsh, and a very wet mix. For example, many modern high-performance concrete buildings were designed for a slump of about 200 mm, which displays collapse slump effect. In in-situ and laboratory, the slump measurements start immediately after water and concrete ingredients contact with each other. In the work, since concrete was prepared at a room temperature of 23 ± 5 °C and of 53% humidity maintained constantly, the determined slump did not affect factors mentioned previously.

Fig. 8 shows slump heights of new cement concrete and Portland cement concrete with water-to-cement ratio 0.52 and their standard errors.

Additionally, the planned target slump height is 12 cm for both cement concretes. The Portland cement concrete exceeded the target height of slump with only 0.5 cm, while new cement concrete did not reach out to the target, its slump height was 10.3. It is clear that the greater water-to-cement ratio causes a higher slump height in concrete. This is attributed to the fact that water makes cement transform into dye, not binding material. In other words, water breaks up binder property of cement and leads to degrading of the strength of concrete, especially compressive strength.

For that reason, the chosen water-to-cement ratio in the study is enough for both new cement concrete and Portland cement concrete. Since the more water-to-cement ratio will lead to a lower mechanical strength is in concrete at all curing ages and different curing conditions, the ratio of w/c 0.52 would be constant for following sections and the CS and the STS are determined within the given w/c ratio. This will provide standard strength development for new cement concrete, like Portland cement concrete has. Lastly, the workability of concrete is very non-objective.

The workability of concrete was sorted into three classes: qualitative, quantitative empirical and quantitative fundamental. Class I is qualitative method which is based on observation of workability, flowability, compactibility, stability, finishability, pumpability, consistency. Class II is quantitative empirical way which uses simple quantitative tests of slump, compacting factor and Ve–be, instead. Class III is a quantitative method uses viscosity and yield stress. Since slump was determined with quantitative empirical way, workability of new cement concrete is Class II.

3.9. Compressive strength

Mechanical properties depend on many factors in concrete. Major factors are the sample type, size, w/c, and test condition. A number of research measure the property through various sizes of hardened concrete and different water-to-cement (w/c) ratio. This is like comparison of apple with pear because of the fact that the preparation and w/c of concrete are not the same in the mechanical test. In order to prevent compressive strength results from any errors, all conditions regarding on the preparation, size, and w/c, and so on were kept constant in the work. The lines of the test result of compressive strength of cylinder concretes of the new cement concrete and of Portland cement concrete on which dry curing and water curing methods were applied can be seen in Fig. 9. The compressive strength of new cement concrete and of Portland cement concrete produced were calculated with the ASTM C-39/39M-21 standard [30] in the reference method that all laboratory uses. For that reason, the results could be repeated in a laboratory that can be found in any part of the world.

The compressive strength test of the cylinder concrete made of Portland cement by using water curing method results in 22.37 MPa, and it results in 19.71 MPa when the dry curing method is used. The compressive strength test for the cylinder concrete made of new cement using maintaining method of water curing results in 8.52 MPa, and it results in 14.52 MPa when the dry method is used. Although the compressive strength of new cement concrete is the lowest,

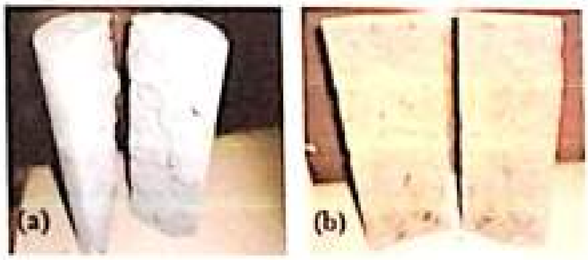

Fig. 11 – (a) Failure form of splitting tensile force at concrete cylinder made of new cement; and (b) failure form of splitting tensile force at concrete cylinder made of Portland cement.

the rate of compressive strength gain of new cement concrete is greater than that of Portland cement concrete.

Because the results of the new cement concrete and Portland cement concrete are very close to each other, it is concluded that the new cement and the new cement concrete could provide the demand of green binder and of green binder material for construction technology.

Moreover, it is necessary to review the chemical component of new cement on the compressive strength gain of new cement concrete. Since it contains much more oxides of calcium, silicon, iron, aluminum, magnesium, sodium, potassium, and sulfate, and lower gypsum content than that of Portland cement, new cement concrete demonstrates the slow compressive strength gain. This could be attributed to the lack of gypsum content in new cement concrete.

3.10. Splitting tensile strength

Fig. 10 shows the graph comparisons of graphs between splitting tensile strengths of cylinder concrete made of new cement and of Portland cement. Results indicate that the test of material enables to endurance against force of splitting tensile. Additionally, the ratio of the splitting tensile strength of concrete shows to the compressive strength of concrete approximately 0.05–0.1.

Concrete made with Portland cement and cured in water has the highest splitting tensile strength. Water curing method results in 2.03 MPa splitting tensile strength for Portland cement concrete, while dry curing method leads to 1.59 MPa splitting tensile strength for Portland cement concrete.

Concrete made with new cement and dry cured shows a higher splitting tensile strength than those treated at water curing. The water curing method results in 0.96 MPa splitting tensile strength, while dry curing method leads to 1.22 MPa splitting tensile strength in concretes made of new cement. Fig. 11 shows the failure patterns of concrete made with ordinary cement and the new cement at 28 days of curing. The failure pattern is similar for both types of cement.

Finally, despite the fact that the new cement is finer than the Portland cement, this is not a factor to affect the splitting tensile strength of new cement concrete positively. Curing conditions, wet curing and dry curing, are the most important contributing factors for the splitting tensile strength of new cement concrete. Because the splitting tensile strength results of new cement concrete and Portland cement concrete are very close to each other, it could be inferred that the new cement concrete could be a promising new green binder.

4. Conclusions

From the results of examination of fineness, density, consistency, setting-time, mineralogy, and chemical properties of new cement, there are similarities with the properties of Portland cement. This can be referred to the physical test results, XRF analysis, and XRD analysis of new cement.

The new cement is finer than Portland cement with a solid weight of 1200 m^2/kg, lighter than Portland cement which reaches 1250 m^2/kg. The specific gravity of Portland cement is 3.15 g/ml while the density of new cement is 3.05 g/ml. The initial setting time of Portland cement was carried out 90 min where the Vicat needle penetrated into the cement paste for 24 mm. The initial setting time of the new cement was also tested by the same method by penetrating 25 mm of cement for 105 min after the needle was removed. The final setting time of Portland cement is 180 min while the new cement reaches 225 min. Based on the results of slump, compressive strength, and splitting tensile strength, it can be concluded that new cement manufactured can be used for structural and non-structural work as well as for the installation of brick walls and for covering the walls with stucco. This demonstrated the ability of new cement to undergo chemical setting and binding of aggregate as a support material in a key process of construction work.

Additionally, the problem of waste and the effort of saving the environment from the accumulation of waste can be overcome wisely through this approach of experimental study, as this work has achieved to make new cement be an alternative binder material for construction industry, especially at dry curing condition.

Availability of data and materials

The "Experimental and Numerical Research" data used to support the findings of this study are available from the corresponding author upon request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jmrt.2021.09.140.

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Analisis Sifat Fisik Semen Organik Terbuat dari Bahan Limbah Daur Ulang

*** Muhammad Syarif [1]**

[1] Jurusan Arsitektur, Fakultas Teknik, Universitas Muhammadiyah, Makassar, Indonesia
muhsyarif09@gmail.com

*Alamat korespondensi, Masuk: 01 Jan. 2019, Direvisi: 15 Jan. 2019, Diterima: 05 Feb. 2019

ABSTRAK: *Penelitian ini bertujuan sebagai penyelamatan lingkungan dan penemuan bahan bangunan alternatif terbaru. Dalam penelitian ini, telah menghasilkan semen organik yang merupakan semen alternatif terbaru selain dari semen portland yang dibuat melalui sistem daur ulang limbah organik, fly ash, bottom ash, dan substitusi tanah mediteran. Metode yang digunakan dalam penelitian ini adalah pengujian laboratorium. Pengujian digunakan untuk menentukan unsur senyawa kimia pada masing-masing bahan utama semen organik. Dari hasil analisis senyawa kimia semen organik melalui metode pengujian laboratorium, telah ditemukan indikasi yang mirip dengan senyawa kimia semen portland dalam bentuk: CaO; 65,36%, SiO2 18,84%, Al2O3 6,33%, Fe2O3 2,29%, SO3 3,64%, MgO 1,35%, C3S 66, 72%, C2S 3,98%, C3A 12,9%, dan C4Af 6,97%. Bleeding beton semen organik untuk 1 m³ adalah 23,88 ml/cm², lebih rendah dari bleeding beton semen portland yang mencapai 31,83 ml/cm². Kadar udara beton semen organik dalam 1 m³ adalah 2,2%, sedang kadar udara beton semen portland mencapai 1,9%. Berat unit semen organik diperoleh 1.200 kg/m³, lebih ringan dari semen portland yang mencapai 1.250 kg/m³*

Kata kunci: Tanah mediteran, Semen organik, Limbah organik, Semen portland

ABSTRACT: This research aims to the environmental saving process and the discovery of the latest alternative building materials. In the research, the researchers have produced an organic cement that is the latest alternative cement aside from portland cement which is made through organic waste recycling system, fly ash, bottom ash, and substitution of mediteran soil and clay. The method used in this research is laboratory testing. The testing is used to determine the element of chemical compound on each organic cement's main ingredients. From the analysis result of chemical compound of organic cement through laboratory testing method, it has been found indication that similar to chemical compound of portland cement in the form of: CaO; 65.36%, SiO2 18.84%, Al2O3 6.33%, Fe2O3 2.29%, SO3 3.64%, MgO 1.35%, C3S 66 , 72%, C2S 3.98%, C3A 12.9%, and C4Af 6.97%. The bleeding of 1 m³ organic cement concrete is 23,88 ml cm², which is lower than the bleeding of portland cement concrete that reaches 31,83 ml/cm². The air content of 1 m³ organic cement concrete is 2,2%, which is lower than the air content of portland cement concrete that reaches 1,9%. The obtained alternative cement solid weight is 1200 kg/m³ more light from portland cement which reaches 1250 kg/m³.

Keywords: Mediteran soil, organic cement, organic waste, portland cement

PENDAHULUAN

Penekanan hasil penelitian berorientasi pada pemanfaatan daur ulang limbah pada bahan yang tidak berkontribusi banyak dalam kehidupan masyarakat sejauh ini. Semen organik adalah semen alternatif terbaru selain dari semen portland yang dibuat melalui sistem daur ulang limbah organik dan substitusi tanah mediteran [1].

Semakin meningkatnya pertumbuhan penduduk dunia maka bahan bangunan perlu juga diatasi dengan melakukan penelitian melalui pemanfaatan limbah daur ulang untuk mendapatkan bahan bangunan yang bisa menjadi bahan alternatif [2]. Saat ini, masalah sampah adalah masalah yang dihadapi di seluruh dunia. Tingginya volume limbah memiliki dampak negatif terhadap lingkungan. Penanganan pengelolaan limbah perlu dilakukan untuk memperkecil dampak negatif yang dapat dihasilkan. Masalah sampah sepertinya bukan hal yang sederhana, karena selama ada kehidupan manusia maka masalahnya akan selalu muncul.

Pengelolaan sampah kota di Indonesia menjadi masalah nyata seiring dengan meningkatnya pertumbuhan populasi yang berdampak pada meningkatnya jumlah sampah dan terjadinya masalah degradasi estetika di sekitar TPA yang berpotensi menyebabkan konflik sosial dengan masyarakat sekitar [3].

Sampah adalah barang atau benda yang tidak memiliki nilai manfaat dan menciptakan kesan negatif yang menyebabkan sampah tersebut dipandang sebagai benda yang harus dibuang dari halaman rumah dengan cara apa pun [4]. Pertumbuhan volume sampah yang tinggi seringkali bertepatan dengan tingginya tingkat pertumbuhan populasi. Oleh karena itu, masalah limbah saat ini dapat dikatakan sebagai masalah dunia yang dihadapi. Selain itu, dengan penanganan yang baik dan pengelolaan limbah yang baik, penghematan lingkungan telah dilakukan. Penanganan limbah organik melalui proses pembakaran dengan tungku pada suhu 700o C akan menjadi abu yang mengandung unsur 69,7% $CaCO_3$, 12,1% KCl; 3% SiO_2, 8,1% Fe dan 3% Al_2, sedangkan abu kerang mengandung 100% $CaCO_3$ [5].

Seiring dengan pertumbuhan ekonomi, produksi sampah per kapita akan terus meningkat sehingga prediksi pada tahun 2030 akan mencapai 1,2 kg/kapita/hari untuk daerah perkotaan dan 0,55 kg/orang/hari untuk daerah pedesaan.

Di Indonesia sampah organik memiliki persentase tertinggi dibanding sampah anorganik. Proporsi limbah organik adalah antara 34-70%, 20-30% lebih tinggi daripada kebanyakan negara di Eropa [6].

Tanah Mediteran adalah tanah yang terbentuk dari pelapukan batuan sedimen dan batuan kapur. Jenis tanah ini mengandung sejumlah besar karbonat dan senyawa lain dari besi, air, aluminium, dan beberapa bahan organik lainnya [7].

Tanah liat akan mengalami perubahan kimia ketika tanah liat dibakar, baik lempung primer dan sekunder. Perubahan pertama yang terjadi pada tanah liat primer dan sekunder ketika dibakar, adalah hilangnya air bebas, terutama untuk tanah liat sekunder akan diikuti oleh pembakaran bahan organik lainnya, seperti humus, daun, dan ranting yang terkandung dalam tanah liat. Pada perubahan selanjutnya, kandungan air kimia akan hilang. Tanah liat primer dan sekunder mengandung silika bebas dalam bentuk pasir, kuarsa, batu api, dan kristal. Silika adalah subjek untuk mengubah bentuk dan volume tanah liat pada suhu tertentu. Beberapa perubahan diperbaiki (konversi) dan lainnya dapat dibalik. Tanah liat yang melalui proses pembakaran dengan suhu melebihi 600°C akan berubah menjadi mineral padat, keras dan permanen [8].

Meningkatnya permintaan akan perumahan dan infrastruktur secara otomatis menuntut kebutuhan akan bahan bangunan yang terus meningkat. Meningkatnya kebutuhan bahan bangunan harus diatasi dengan penggunaan dan penemuan bahan bangunan yang dapat memberikan alternatif. Peningkatan pertumbuhan semen sampai saat ini masih dipengaruhi oleh pembangunan yang cukup tinggi yang dilakukan oleh sektor swasta karena tingginya permintaan perumahan bagi masyarakat [9].

Semen yang mengandung unsur mineral sebagai pengganti semen portland dikenal sebagai semen komposit, semen campuran atau semen alternatif. Komponen mineral yang ditambahkan disebut mineral tambahan yang reaktif dan berkontribusi pada proses hidrasi. Semen yang mengandung unsur mineral sebagai pengganti semen portland dikenal sebagai semen komposit, campuran semen atau semen alternatif. Komponen mineral yang ditambahkan disebut mineral tambahan yang reaktif dan berkontribusi pada proses hidrasi. Penggunaan fly ash jenuh adalah salah satu cara untuk mengurangi proses hidrasi semen dalam beton [10].

Limbah batu bara dalam bentuk fly ash yang dihasilkan dari hasil pembuangan pembakaran pembangkit listrik umumnya masih terabaikan untuk digunakan di sebagian besar negara [11].

Semakin besar persentase hidrasi fly ash, maka waktu pengikatan awal dan akhir lebih lambat. Senyawa C3S, C2S, C3A dan C4AF akan bereaksi dengan air, dimulai dengan senyawa C3A bereaksi dengan unsur-unsur utama yang ada dalam abu terbang silika dan alumina sehingga rantai reaksi hidrasi akan sangat lama yang pada akhirnya akan meningkatkan waktu pengikatan beton. Semakin besar kandungan fly ash sebagai pengganti jumlah semen dalam campuran beton, senyawa C3S, C2S, C3A dan C4AF akan berkurang karena hal ini akan mengakibatkan berkurangnya panas hidrasi. Panas hidrasi yang berkurang akan memperlambat reaksi sehingga akan memperlambat waktu pengikatan [12].

Butiran fly ash yang terbaik digunakan adalah yang lolos saringan 200 mesh yang mengandung SiO_2, Al_2O_3, P_2O_5, dan Fe_2O_3. Kandungan silika yang cukup tinggi memungkinkan abu batubara memenuhi kriteria sebagai bahan yang memiliki sifat semen / pozzolan [13]. Penggunaan fly ash menciptakan pengurangan emisi polusi udara yang berdampak negatif terhadap perekonomian, telah diamati bahwa 0,9 ton CO2 dihasilkan per ton produksi semen. Dengan demikian penggunaan fly ash memungkinkan untuk mengurangi emisi CO2 atmosfer sebagai bentuk rekayasa ramah lingkungan [14]. Efek penambahan sejumlah abu terbang akan meningkatkan kekuatan beton [15].

Pengembangan penggunaan sumber-sumber arletranif untuk pembuatan semen juga telah dikembangkan oleh Jepang yang memproduksi semen ramah lingkungan yang terbuat dari abu limbah kota melalui pembakaran sebagai pengganti beberapa bahan baku utama yang mengandung 50% bahan baku semen seperti limbah lumpur [16].

Untuk membuat Klinker Eco-Semen CSA maka bahan baku awal yang tepat perlu dibakar pada suhu maksimum 1200-1300 ° C. Penggunaan kembali bahan limbah dalam bentuk phosphogypsum akan mengurangi suhu dan waktu proses pembakaran. Pembuatan semen skala besar dapat dilakukan dalam rotary kiln konvensional yang digunakan untuk semen portland dan memproduksi mineralisasi semen kimia C = CaO, A = Al2O3, S = SiO2, s = SO3, F = Fe2O3, M = MgO. Ye'elimite 4CaO • 3Al2O3 • SO3 yaitu C4A3s [17].

METODE DAN INSTRUMEN PENELITIAN

Dalam penelitian eksperimental ini, pengujian dilakukan pada konsentrat semen organik dan dilakukan pada konsentrat bahan baku utama pembentukan semen organik melalui pengujian laboratorium kimia. Pengujian digunakan untuk menentukan elemen kimia serta strukturnya untuk mengetahui sifat fisiknya. Pengujian analisis pada aboratorium kimia adalah senyawa CaO, SiO2, Al2O3, Fe2O3, SO3, MgO, Loi, Na2O, K2O, C3S, C2S, C3A dan C4Af. Metode pengujian elemen kimia mengacu pada ASTM C-114-07 [18]. Referensi tersebut adalah referensi normatif yang dianggap sangat relevan dalam proses pengujian senyawa kimia seme

Metode pengujian sifat fisik dilakukan di laboratorium struktur dan bahan yang meliputi bleeding, kadar udara, dan pengujian berat unit pada beton semen organik dan beton semen portland. Untuk melihat kelayakan semen organik, sampel uji juga mencakup pengujian senyawa kimia untuk tanah mediteran, limbah organik berupa limbah rumah tangga, fly ash, bottom ash dan tanah liat. Sampel pembanding yang digunakan dalam pengujian eksperimental ini adalah semen Portland.

HASIL DAN PEMBAHASAN

Semen organik dibentuk dengan memanfaatkan substitusi bahan alami berupa tanah mediteran dengan pengelolaan bersama mendaur ulang limbah organik dalam bentuk limbah rumah tangga, fly ash, bottom ash dan tanah liat. Setelah semua bahan baku diproses, dilakukan pengujian terhadap unsur-unsur kimia yang dimiliki pada masing-masing bahan baku tersebut. Kemudian, setelah pencampuran bahan baku untuk membentuk klinkernisasi, pengelolaan bahan dilakukan sampai membentuk konsentrat semen organik. Selanjutnya, konsentrat semen organik ini juga diproses dengan pengujian elemen kimia. Untuk melihat kelayakan konsentrat semen organik sebagai semen alternatif, pengembangan penelitian yang dilakukan oleh peneliti adalah menganalisis konsentrat semen organik pada pemeriksaan sifat fisik berupa bleeding, kadar udara, dan pengujian berat unit.

Hasil pengujian kuat tekan silinder beton yang menggunakan semen portland pada metode water curing menghasilkan 22,37 MPa sedang untuk metode dry curing menghasilkan 19,71 MPa. Untuk beton semen organik pada metode perawatan water curing menghasilkan 8,52 MPa sedang untuk metode dry curing menghasilkan 14,52 Mpa [19].

Senyawa Kimia dan Karakteristik Semen Organik

Pengujian elemen kimia dimaksudkan untuk menentukan kandungan senyawa kimia dengan membandingkan senyawa kimia yang terkandung dalam semen portland. Konsentrat semen organik dibentuk dengan meman faatkan substitusi bahan alami dalam bentuk tanah mediteran dan daur ulang limbah organik yang merupakan limbah rumah tangga, fly ash, bottom ash dan tanah liat. Tabel 1 menunjukkan hasil pengujian unsur kimia konsentrat semen organik. dan tabel 2 menunjukkan hasil pengujian unsur utama semen organik

Tabel 1. Elemen kimia konsentrat semen organik dibandingkan dengan semen portland berdasarkan ASTM C114-07

Parameter	Unit	Results	
		Organik Semen	Portland cement (ASTM – C 114)
C_3S	%	69,90	50-70
C_2S	%	7,30	15-30
C_3A	%	10,3	5-10
C_4AF	%	3,1	5-15
SiO_2	%	21,29	20,6
Al_2O_3	%	7,86	5,07

Fe_2O_3	%	4,40	2,9
CaO		68,43	63,9
SO_3	%	3,20	2,53
Na_2O+K_2O	%	1,58	0,88
MgO	%	4,80	1,53

Tabel 2. Unsur kimia adalah bahan utama konsentrat semen organik

Parameter	Unit	Hasil				
		Sampah Orgaik	Tanah Mediteran	Tanah Liat	Fly Ash	Bottom Ash
SiO_2	%	46,65	23,68	30,63	22,14	15,20
Al_2O_3	%	2,28	0,44	3,41	3,84	2,99
Fe_2O_3	%	0,18	0,15	0,20	0,20	0,20
CaO	%	11,09	19,35	0,51	6,87	1,41
SO_3	%	1,01	1,66	0,01	0,89	0,15
Na_2O	%	2,24	0,01	0,23	0,37	1,03
K_2O	%	11,98	0,09	0,02	0,58	0,17
MgO	%	0,02	0,018	0,36	0,03	0,02

Gambar 1 menunjukkan proses pembakaran bahan utama semen organik. Pembakaran bahan baku dilakukan dalam mesin pembakaran yang dapat menahan panas hingga 1800o C. Kontrol suhu pembakaran dengan menggunakan alat termometer TI-1500 infra red sanfix. Pemeriksaan senyawa kimia dilakukan di laboratorium kimia Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Hasanuddin dan untuk mengetahui sifat fisiknya, dilakukan di laboratorium bahan, struktur dan konstruksi Fakultas Teknik Arsitektur Universitas Hasanuddin.

Gambar 1. Proses pembakaran bahan utama semen organik

Untuk membentuk konsentrat semen organik, semua bahan utama dibakar hingga suhu 1400o C. Setelah semua bahan dibakar selama 4 jam, pendinginan dan penyempurnaan dilakukan. Bahan berbentuk konsentrat kemudian menjalani pengujian senyawa kimia untuk melihat pendekatan kelayakan elemen kimia terhadap elemen kimia semen portland. Uji sifat fisik dimaksudkan untuk melihat kelayakan fisik semen organik dalam bentuk kehalusan, dan kepadatan.

Gambar 2 di bawah ini menunjukkan bahan baku semen organik sebelum proses manajemen menjadi konsentrat semen organik.

A B C D E

Gambar 2. Tanah Mediteran (A), Limbah rumah tangga (B), Clay (C), Fly ash (D), Bottom Ash (E).

Bleeding dan Kadar Udara Semen Organik

Jumlah air bleeding untuk beton semen organik dengan berat beton silinder 3,33 kg sebesar 0,04 ml/cm² sehingga prediksi pendarahan air untuk beton 1 m³ dengan semen organik adalah 23,88 ml/cm². Sedang untuk beton yang menggunakan semen portland dengan berat beton silinder 3,36 kg memiliki nilai air bleeding sebesar 0,05 ml/cm² dengan prediksi bleeding untuk 1 m³ beton semen portland adalah 31,83 ml/cm².

Gambar 3 berikut ini menunjukkan proses pengukuran air bleeding pada beton semen organik.

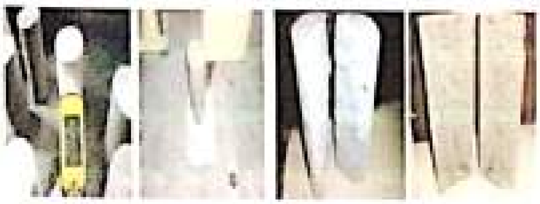
Pengujian volume air bleeding silinder beton dihitung dengan referensi berdasarkan ASTM C 232-99 [20].

A B

Gambar 3. Proses pengukuran pendarahan (A), proses pengukuran konten udara (B)

Berat Unit

Berat beton segar menggunakan semen organik adalah 2081 kg / m³ dan berat beton keringnya adalah 2032 kg / m³, sedangkan berat beton segar dengan menggunakan semen portland adalah 2525 kg / m³ kemudian berat beton keringnya adalah 2405 kg / m³. Gambar 4 menunjukkan silinder beton yang terbuat dari semen organik dan konsentrat semen portland. Pada gambar tersebut juga menunjukkan proses pengukuran suhu, berat spesimen, dan kondisi beton silinder yang telah diuji tarik.



A B C D

Gambar 4. Pengukuran temperatur beton silinder dengan semen organik (A), Pengukuran berat beton silinder dengan semen organik (B), silinder beton dengan semen organik hasil uji tarik (C), silinder beton dengan semen portland hasil uji tarik (D)

KESIMPULAN DAN SARAN

Dari hasil pengujian sifat kimia dan sifat fisik konsentrat semen organik, telah diperoleh indikasi yang mirip dengan sifat senyawa kimia semen portland yang dalam hal ini digunakan sebagai sampel pembanding. Dalam meningkatkan kualitas semen organik, dipandang perlu untuk melakukan penelitian eksperimental lanjutan. Dalam desain campuran beton yang sama meskipun uji kompresi beton dengan semen organik masih lebih rendah dari beton yang menggunakan semen portland, tetapi semen organik ini dapat digunakan untuk konstruksi ringan.

Adapun hasil pengujian sifat fisis yang dimiliki semen organik berdasarkan kajian empiris dinyatakan telah mendekati acuan normatif pada Standar Nasional Indonesia (SNI) dan ASTM

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