tion, the use of shell aggregate does not affect the construction quality and can significantly reduce the price of building materials, so the use of shell aggregate can produce considerable social and economic benefits.

References

1. Ma H L, Cui C, Li X, et al. Study on mechanical properties of steel fiber reinforced autoclaved lightweight shell-aggregate concrete[J]. Materials & Design (1980–2015), 2013, 52: 565–571.

2. Khaldoun Rahal,Mechanical properties of concrete with recycled coarse aggregate,Building and Environment,Volume 42, Issue 1,2007, 407–415.

3. ZHAO Hui, XUAN Weihong, FENG Jiarui, et al. Research Progress on Recycling Technology of Waste Shells[J]. Journal of Jinling Institute of Science and Technology, 2019, 35(1): 34–39.

4. Yoon G L, Kim B T, Kim B O, et al. Chemical–mechanical characteristics of crushed oyster-shell[J]. Waste management, 2003, 23(9): 825–834.

5. Martínez-García C, González-Fonteboa B, Martínez-Abella F, et al. Performance of mussel shell as aggregate in plain concrete[J]. Construction and building materials, 2017, 139: 570–583.

6. Ez-Zaki H, Diouri A, Kamali-Bernard S, et al. Composite cement mortars based on marine sediments and oyster shell powder[J]. Materiales de construcción, 2016, 66(321): e080–e080.

EVALUATION OF GRAPHENE CONCRETE IN A GREEN ENERGY ECONOMY

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Annotation. This paper discusses the development of graphene concrete and the composition and mechanical application properties of graphene concrete and evaluates its economic sustainability based on its basic properties of green energy.

After the global financial crisis of 2008–2009, the concepts of "low carbon economy", "new green economy" and "green economic growth" have received increasing policy and media attention due to the gradual reduction of non-renewable energy sources and the diminishing value of the economy. concepts such as "Low Carbon Economy", "New Green Economy" and "Green Economic Growth" are receiving more and more policy and media attention. In the coming years, graphene oxide may have a huge impact on the concrete and construction-related industries. Due to the oxidizing ability associated with the aromatic structure, it has improved dispersion in mixtures compared to other graphene-based materials. Therefore the huge green energy economic benefits of graphene concrete are significant. How to turn graphene concrete into a new green energy derivative and expand its economic use value is an important research direction of the current energy economy and a necessary path for the sustainable development of green economy. Therefore, it is very necessary to launch the economic evaluation of graphene concrete.

It is well known that carbon nanotubes, graphene oxide and graphene can enhance the thermophysical, mechanical, optical and electrical properties of concrete composites. Many researchers and scholars have made an in-depth study on [1] how to carry out carbon nanotube enhanced concrete mixtures and analyzed their durability and mechanical properties in detail with reference to the base parameters of the concrete mixtures, and the results of the study show that carbon nanotubes and graphene oxide concrete gives better results. Hence graphene oxide is known as carbon-based nanomaterials. Incorporation of graphene oxide in the cement matrix is a future trend in the construction industry due to the excellent properties of graphene. Graphene oxide is very cheap compared to expensive single and multi-walled carbon nanotubes and carbon nanofibers, hence the worldwide interest in graphene oxide. It has become a new green energy source, as well. So, energy economics of graphene oxide concrete is a suitable choice for this study. The objective of this study is to analyze the energy economy of graphene concrete with the sustainable performance of green economy. It seeks to improve resource efficiency, encourage low carbon energy technologies, reduce greenhouse gas emissions, reduce dependence on fossil fuels, increase investment in maintaining natural capital, and reduce economic inequality.

Assessment formula and methodology: all the application data of graphene concrete was tabulated and after the following equation, diamond grid data plotting was carried out and relevant conclusions were drawn.

The indicators values were transformed to derive normalized values on a scale of 1–10 based on the minimum and maximum values. The min–max normalization approach (Jiawei 2011) was used by Tongsopit et al. (2016) for linear transformation of data.

$$A = \frac{X - Min_{\alpha}}{Max_{\alpha} - Min_{\alpha}}, \qquad (1)$$

where:

A: normalized value based on original data range α;

X: untransformed indicator;

α: data range of X;

Min_α: minimum value in data range α;

Max_α: maximum value in data range α.

By considering Aminβ = 1 Maxβ = 10.

The equation, in this case, becomes:

$$\frac{X' - 1}{10 - 1} = \frac{X - Min_{\alpha}}{Max_{\alpha} - Min_{\alpha}}, \qquad (2)$$

where:

X':

$$X' = 1 + \left(\frac{X - Min_\alpha}{Max_\alpha - Min_\alpha}\right) \times (10 - 1)\,. \tag{3}$$

For indicators of each category that have a direct relationship with the scale, their high values represent a high improvement of energy security. For instance, a larger share of RE in power generation implies higher energy security. However, some indicators have an inverse relationship with the scale; a higher value reflects less energy security. For example, a larger share of energy imports indicates lower energy security. In such a case, the raw score's maximum value is considered the minimum scale value of the related indicator, which is equal to 1. In contrast, the raw score's minimum value indicates the maximum value that is equal to 10 on the scale.

Therefore, the equation for the inverse normalization appears in the following shape:

$$X' = 1 + \left(\frac{X - Max_\alpha}{Min_\alpha - Max_\alpha}\right) \times (10 - 1)\,. \tag{4}$$

This study explores the changes in the application of graphene concrete from 2018 to 2023 using diamond-shaped area analysis. In order to observe the four periods of rhombus area to determine the green development that indicates the graphene energy. To be used to analyze the graphene concrete in energy security to ensure the sustainability of graphene concrete.

References

1. Zaid O, Hashmi S R Z, Aslam F, et al. Experimental study on the properties improvement of hybrid graphene oxide fiber-reinforced composite concrete[J]. Diamond and Related Materials, 2022, 124: 108883.

2. Alemzero DA, Sun H, Mohsin M, Iqbal N, Nadeem M, Vo XV (2021) Assessing energy security in Africa based on multi-dimensional approach of principal composite analysis. Environ Sci Pollut Res 28:2158–2171. https://doi.org/10.1007/s11356-021-14367-7

3. Ang BW, Choong WL, Ng TS (2015) Energy security: Definitions, dimensions and indexes. Renew Sust Energ Rev 42:1077–1093. https://doi.org/10.1016/j.rser.2014.10.064

4. Asia Pacific Energy Research Centre – APERC (2007) Quest for energy security in the 21st century: resources and constraints. APERC, Tokyo.

5. Berrada K (2018) Jerada beyond the mine, a sustainability approach.

6. Jerada beyond the Mine A Sustainability Approach. – Url: https://mipa.institute/wp-content/uploads/2018/09/Berrada-English.pdf.