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MODERN FORMWORK SYSTEMS FOR MONOLITHIC CONSTRUCTION: CHALLENGES AND APPLICATION POTENTIAL OF BASALT FIBER REINFORCED POLYMER COMPOSITES

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Abstract: The rapid growth of monolithic construction has significantly increased the demand for high-performance formwork systems capable of improving construction efficiency, structural quality, and economic performance. Conventional formwork materials, including timber, steel, and aluminum, have been widely adopted in modern construction; however, they continue to exhibit several limitations such as high self-weight, susceptibility to corrosion, limited service life, geometric instability, and increased maintenance costs. These challenges have encouraged researchers to investigate alternative materials with superior mechanical and durability characteristics. The analysis indicates that BFRP composites possess a unique combination of high specific strength, low density, excellent corrosion resistance, and long-term durability, making them promising candidates for next-generation formwork systems. Nevertheless, despite the extensive application of BFRP in structural reinforcement and bridge engineering, its use in permanent and reusable formwork systems remains insufficiently investigated. This study identifies the existing research gap and proposes future research directions focused on structural optimization, numerical modeling, experimental validation, and sustainable design of composite formwork systems. The findings provide a scientific basis for developing lightweight, durable, and environmentally sustainable formwork technologies for modern monolithic construction.

Keywords: Monolithic construction; Formwork systems; Basalt fiber reinforced polymer (BFRP);

Annotatsiya: Monolit qurilishning jadal rivojlanishi qurilish samaradorligini, konstruksiya sifatini va iqtisodiy ko'rsatkichlarni oshirishga qodir yuqori samarali qolip tizimlariga bo'lgan ehtiyojni sezilarli darajada kuchaytirdi. Yog'och, po'lat va alyuminiy kabi an'anaviy qolip materiallari zamonaviy qurilishda keng qo'llanilishiga qaramay, ular yuqori xususiy og'irlik, korroziyaga moyillik, cheklangan xizmat muddati, geometrik barqarorlikning yetarli emasligi hamda ekspluatatsiya va texnik xizmat ko'rsatish xarajatlarining yuqoriligi kabi qator kamchiliklarga ega. Mazkur muammolar tadqiqotchilarni yuqori mexanik xususiyatlarga va uzoq muddatli chidamlilikka ega bo'lgan muqobil materiallarni izlashga undamoqda.

O'tkazilgan tahlillar bazalt tolasi bilan armaturalangan polimer kompozitlar (BFRP) yuqori solishtirma mustahkamlik, past zichlik, korroziyaga yuqori chidamlilik va uzoq muddatli ekspluatatsion barqarorlik kabi noyob xususiyatlar majmuasiga ega ekanligini ko'rsatdi. Ushbu xususiyatlar ularni yangi avlod qolip tizimlarini yaratish uchun istiqbolli material sifatida baholash imkonini beradi. Shunga qaramay, BFRP materiallari konstruksiyalarni mustahkamlash va ko'priklarni muhandisligida keng qo'llanilishiga qaramasdan, ularning doimiy va qayta foydalaniladigan qolip tizimlarida qo'llanishi hali yetarli darajada o'rganilmagan.

Mazkur tadqiqot mavjud ilmiy bo'shliqni aniqlaydi hamda kompozit qolip tizimlarini konstruktiv optimallashtirish, sonli modellash, eksperimental sinovlar va barqaror loyihalash yo'nalishlarida kelgusidagi ilmiy izlanishlar uchun ustuvor yo'nalishlarni taklif etadi. Tadqiqot natijalari zamonaviy monolit qurilish uchun yengil, uzoq muddat xizmat qiluvchi va ekologik barqaror qolip texnologiyalarini ishlab chiqishning ilmiy asoslarini shakllantiradi.

Kalit so'zlar: Monolit qurilish; qolip tizimlari; bazalt tolasi bilan armaturalangan polimer (BFRP);

Аннотация: Стремительное развитие монолитного строительства существенно увеличило потребность в высокоэффективных опалубочных системах, способных повысить эффективность строительных процессов, качество конструкций и экономическую результативность строительства. Традиционные материалы для изготовления опалубки, включая древесину, сталь и алюминий, широко применяются в современной строительной практике, однако они по-прежнему обладают рядом существенных недостатков, таких как высокая собственная масса, подверженность коррозии, ограниченный срок службы, недостаточная геометрическая стабильность, а также

повышенные затраты на эксплуатацию и техническое обслуживание. Эти проблемы стимулируют исследователей к поиску альтернативных материалов с улучшенными механическими характеристиками и высокой долговечностью.

Проведённый анализ показывает, что полимерные композиты, армированные базальтовым волокном (BFRP), обладают уникальным сочетанием высокой удельной прочности, низкой плотности, превосходной коррозионной стойкости и долговечности, что делает их перспективными материалами для создания опалубочных систем нового поколения. Вместе с тем, несмотря на широкое применение BFRP в усилении строительных конструкций и мостовом строительстве, их использование в постоянных и многоразовых опалубочных системах остаётся недостаточно изученным.

Настоящее исследование выявляет существующий научный пробел и предлагает перспективные направления дальнейших исследований, связанные со структурной оптимизацией, численным моделированием, экспериментальной верификацией и устойчивым проектированием композитных опалубочных систем. Полученные результаты формируют научную основу для разработки лёгких, долговечных и экологически устойчивых технологий опалубки, предназначенных для современного монолитного строительства.

Ключевые слова: Монолитное строительство; опалубочные системы; полимерные композиты, армированные базальтовым волокном (BFRP);

INTRODUCTION

Concrete has remained the principal material of modern structural engineering because of its adaptability, mechanical reliability, and economic feasibility. Nevertheless, the performance of a reinforced concrete structure is determined not only by the properties of hardened concrete but also by the construction technologies employed during its placement. Among these technologies, formwork occupies a unique position. It defines the geometry of structural members, preserves dimensional accuracy during casting, transfers fresh concrete pressure safely, and directly influences construction time, labour productivity, surface quality, and project cost (ACI Committee 347, 2014).

The increasing complexity of contemporary buildings has fundamentally altered the engineering requirements imposed on temporary construction systems. High-rise buildings, long-span structures, transportation facilities, and architecturally irregular projects require construction technologies capable of maintaining structural precision while supporting accelerated construction schedules. Under these conditions, monolithic reinforced concrete construction has become one of the most widely adopted structural solutions because it enables the formation of continuous load-bearing systems with improved stiffness, structural integrity, and seismic resistance compared with conventional precast construction (Chudley & Greeno, 2020; fib, 2021).

The expansion of monolithic construction has simultaneously elevated the engineering significance of formwork systems. Historically regarded as temporary auxiliary structures, modern formwork systems have evolved into highly engineered assemblies whose mechanical behaviour directly affects both construction efficiency and the quality of completed concrete elements. In practical construction, inaccuracies in formwork alignment, insufficient structural rigidity, excessive deformation, or premature deterioration may compromise dimensional tolerances, increase material consumption, prolong construction cycles, and generate additional finishing work. Consequently, the technical performance of formwork should be evaluated as an integral component of structural production rather than merely as temporary construction equipment (Hurd, 2005; ACI Committee 347, 2014).

Current engineering practice demonstrates that improvements achieved in concrete materials, reinforcement technologies, and digital construction management cannot fully compensate for the limitations of conventional formwork materials. Although timber, steel, and aluminium systems continue to dominate construction practice, each material presents inherent constraints associated with structural weight, corrosion susceptibility, durability, maintenance requirements, or long-term dimensional stability. These limitations become increasingly significant in projects requiring repeated reuse, rapid construction cycles, or operation under aggressive environmental conditions, where both structural reliability and economic efficiency must be maintained throughout the service life of the formwork system (Chudley & Greeno, 2020; fib, 2021).

REVIEW OF LITERATURE ON THE SUBJECT

Formwork systems constitute a critical component of monolithic reinforced concrete construction because they directly influence structural geometry, dimensional accuracy, surface quality, construction safety, labour productivity, and project duration. According to ACI Committee 347 (2014), formwork must safely resist fresh concrete pressure, construction loads, vibration effects, and temporary environmental actions while maintaining the required structural alignment. Hurd (2005) similarly emphasizes that formwork should be regarded not

merely as temporary construction equipment but as an engineered structural system whose rigidity, stability, assembly efficiency, and reuse potential significantly affect the overall quality and cost of concrete construction.

The engineering requirements imposed on formwork systems have increased considerably with the development of high-rise buildings, long-span structures, transport facilities, and architecturally complex projects. Chudley and Greeno (2020) note that modern construction processes require temporary structures capable of supporting accelerated construction schedules without compromising safety or dimensional accuracy. The EN 12812:2008 standard establishes general performance and design requirements for falsework, including structural resistance, stability, deformation control, and operational reliability. These requirements demonstrate that the assessment of formwork systems should involve not only material strength but also load-transfer behaviour, geometric stability, connection performance, and repeated-use conditions.

Traditional formwork systems are generally manufactured from timber, steel, or aluminium. Timber formwork remains widely used because of its availability, low initial cost, and ease of fabrication, particularly in small-scale projects and structures with irregular geometries. However, Hurd (2005) and Chudley and Greeno (2020) indicate that timber is sensitive to moisture, swelling, shrinkage, abrasion, and gradual surface deterioration. These characteristics reduce dimensional stability and limit the number of effective reuse cycles. Steel formwork provides high stiffness, dimensional precision, and durability, making it suitable for repetitive construction operations. Nevertheless, its considerable self-weight increases transportation costs, crane dependency, installation effort, and labour intensity. Steel systems also require protective measures against corrosion, especially under humid or chemically aggressive conditions.

Aluminium formwork offers lower weight and improved corrosion resistance compared with steel systems. Its lightweight panels facilitate rapid assembly and dismantling and may contribute to shorter construction cycles. However, aluminium possesses lower resistance to local impact and deformation under demanding loading conditions. Consequently, none of the conventional materials simultaneously provides low weight, high structural rigidity, corrosion resistance, long service life, and minimum maintenance. The fib Model Code for Concrete Structures 2020 further highlights the increasing importance of durability, life-cycle performance, resource efficiency, and environmental sustainability in concrete construction, thereby creating a need for alternative materials capable of improving the technical and economic performance of reusable formwork systems.

Prefabrication and industrialized construction methods have been widely examined as mechanisms for increasing productivity and reducing on-site labour requirements. Tam et al. (2007) argue that prefabrication can improve construction quality, reduce waste, accelerate project delivery, and enhance site organization. Pan, Gibb, and Dainty (2012) similarly identify design integration, supply-chain coordination, standardization, early planning, and technological compatibility as essential conditions for the successful adoption of prefabricated construction systems. These findings are directly relevant to reusable formwork development because highly standardized, lightweight, and modular panels can facilitate industrial production, repeated application, and rapid construction operations.

Among different reinforcement fibres, basalt fibre has attracted increasing attention because of its favourable mechanical, thermal, chemical, and environmental characteristics. Sim, Park, and Moon (2005) found that basalt fibres exhibit high tensile strength, good resistance to chemical attack, and satisfactory compatibility with concrete-related applications. Their research demonstrated the technical potential of basalt fibres as strengthening materials for concrete structures. Fiore et al. (2015), in a comprehensive review of basalt fibres and basalt-fibre composites, reported that basalt fibres offer a favourable balance of strength, stiffness, thermal stability, chemical resistance, and production cost. Basalt fibres are produced from naturally occurring volcanic rock and generally require fewer additives than some synthetic reinforcement fibres, which may contribute to their environmental attractiveness.

Basalt fibre-reinforced polymer composites may provide several advantages for reusable formwork systems. Their low density can reduce panel weight, simplify manual handling, decrease crane dependency, and improve occupational safety. Their corrosion resistance may also reduce maintenance requirements and extend service life under humid or aggressive construction conditions. Furthermore, the mechanical properties of BFRP can be adjusted through laminate design, fibre orientation, panel geometry, and structural stiffening. This adaptability creates opportunities to develop modular formwork panels that combine structural reliability with high reuse potential and reduced operational costs.

Despite the extensive research on FRP composites in structural strengthening, bridge engineering, reinforcement systems, and infrastructure rehabilitation, their application in reusable formwork remains insufficiently investigated. Existing studies primarily focus on the material behaviour of basalt fibres or the structural performance of BFRP reinforcement, while comparatively limited attention has been given to panel stiffness, connection design, fresh concrete pressure, repeated loading, surface wear, dimensional stability, assembly efficiency, and life-cycle cost in formwork applications. Furthermore, the structural, technological,

economic, and environmental dimensions of BFRP formwork have rarely been analysed within a unified engineering framework.

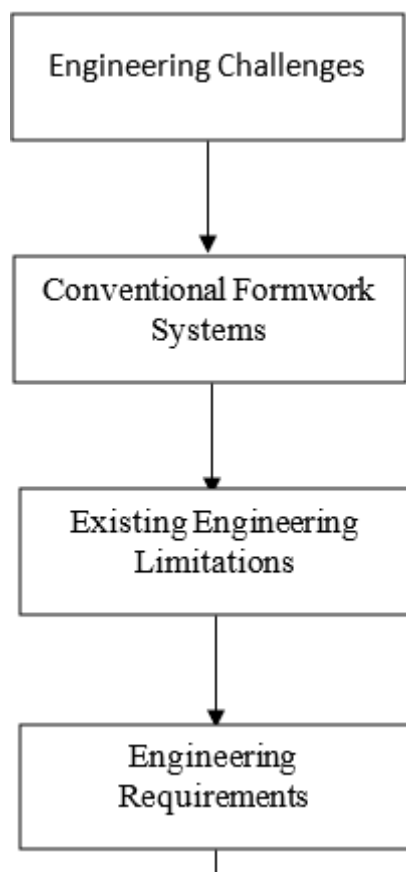
The reviewed literature therefore indicates a clear research gap. Conventional formwork materials possess proven practical advantages but also exhibit limitations related to weight, moisture sensitivity, corrosion, deformation, maintenance, and service life. BFRP composites offer promising material characteristics that could address several of these limitations; however, their suitability for reusable monolithic construction formwork requires comprehensive investigation. Future studies should integrate structural analysis, experimental testing, constructability assessment, durability evaluation, economic comparison, and life-cycle environmental analysis to determine the practical feasibility of BFRP-based formwork systems.

RESEARCH METHODOLOGY

The methodological framework adopted in this study was developed to provide a critical engineering synthesis rather than a descriptive summary of previously published research. Instead of cataloguing existing studies according to publication chronology or application field, the review was structured around engineering problems associated with reusable formwork systems for monolithic reinforced concrete construction. This approach enables the identification of technological relationships that are often overlooked when material science and construction engineering are evaluated independently.

Accordingly, the review follows the principles of a Critical State-of-the-Art Review, in which published evidence is examined through analytical comparison, engineering interpretation, and conceptual integration. Within this framework, individual investigations are considered as components of a broader body of knowledge rather than isolated research outcomes. Emphasis is therefore placed on explaining how developments in formwork engineering, composite materials, structural mechanics, and construction technology collectively influence the future design of reusable formwork systems.

The credibility of any review depends fundamentally on the transparency of its evidence selection process. For this reason, literature retrieval was designed as a structured and reproducible procedure intended to capture the most influential scientific contributions related to formwork engineering, monolithic concrete construction, fibre-reinforced polymer composites, and basalt fibre technologies. Rather than maximising the number of retrieved publications, the search strategy prioritised scientific relevance, engineering significance, and methodological quality (Figure 1).



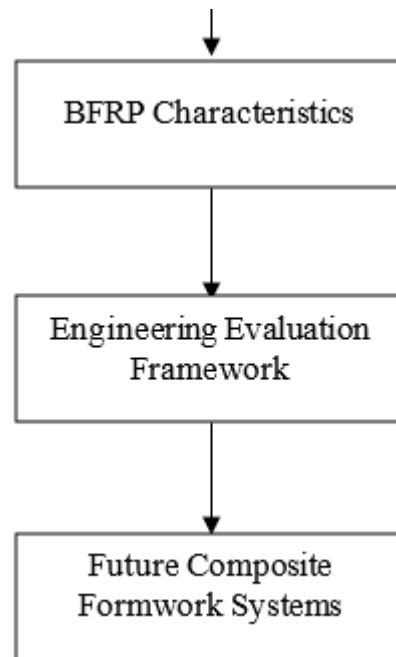


Figure 1. Engineering Evaluation Framework for Modern Formwork Systems in Monolithic Construction

The selected publications were analysed using a comparative engineering approach that emphasised the relationship between material characteristics and formwork performance in monolithic construction. Instead of examining individual studies separately, evidence from experimental investigations, review articles, engineering standards, and technical reports was synthesised to identify recurring findings, conflicting viewpoints, and unresolved research issues. This approach enabled the integration of knowledge originating from construction engineering, materials science, and structural design into a coherent analytical framework.

The comparative analysis focused on five engineering dimensions that consistently determine the performance of reusable formwork systems: structural behaviour, durability, constructability, economic efficiency, and environmental sustainability. These criteria were used throughout the review to ensure that different formwork materials were evaluated according to identical engineering principles rather than isolated material properties. Particular attention was given to studies investigating basalt fiber reinforced polymer composites in civil engineering applications. Although many publications describe the mechanical and durability characteristics of BFRP, their implications for reusable formwork systems remain insufficiently discussed. Consequently, the analytical synthesis presented in this review extends beyond summarising previous findings by identifying relationships between existing evidence and the engineering requirements of modern monolithic construction.

The final stage of the review consisted of interpreting the collected evidence to determine current technological limitations, emerging research directions, and the practical feasibility of integrating basalt fiber reinforced polymer composites into future formwork systems. This synthesis provided the basis for the subsequent critical discussion presented in the following sections.

ANALYSIS AND RESULTS

The evolution of formwork systems has been governed by changes in engineering requirements rather than by the development of construction materials alone. As reinforced concrete became the dominant structural material for buildings and civil infrastructure, increasing structural complexity, larger span lengths, and accelerated construction schedules exposed the limitations of conventional formwork technologies. Consequently, improvements in formwork engineering have historically been driven by the need to enhance structural reliability, construction efficiency, worker safety, and economic performance rather than by the replacement of individual materials (ACI Committee 347, 2014).

One of the principal factors influencing formwork development has been the continuous increase in construction productivity. Modern construction projects are expected to reduce project duration without compromising dimensional accuracy or structural quality. Under these conditions, formwork systems are required to withstand repeated loading cycles, maintain geometric stability during concrete casting, and permit rapid assembly and dismantling. Engineering solutions capable of reducing labour intensity while increasing

reuse potential have therefore become essential components of contemporary construction practice (Hurd, 2005; Chudley & Greeno, 2020).

Structural formwork systems have evolved through successive engineering responses to the increasing technical demands of concrete construction. Early formwork solutions were predominantly timber-based because timber was inexpensive, readily available, and easily fabricated on construction sites. Such systems adequately satisfied the requirements of low-rise buildings and relatively simple structural configurations. However, increasing building heights, larger concrete volumes, and stricter dimensional tolerances gradually exposed the limitations of timber formwork, particularly its limited durability, moisture sensitivity, and inconsistent geometric stability during repeated use (Hurd, 2005).

The industrial expansion of reinforced concrete construction stimulated the introduction of steel formwork systems, which provided substantially greater stiffness, dimensional accuracy, and service life. Their adoption significantly improved construction quality in projects requiring repetitive casting operations, including multistorey buildings, bridges, tunnels, and industrial facilities. Nevertheless, the increased structural weight of steel panels generated additional engineering challenges associated with transportation, crane dependency, labour intensity, and corrosion protection, particularly under aggressive environmental conditions (ACI Committee 347, 2014).

Structural performance represents the primary engineering criterion governing the selection of formwork systems for monolithic concrete construction. Regardless of the material employed, formwork must maintain sufficient stiffness throughout the casting process, preserve dimensional accuracy under fresh concrete pressure, and ensure structural stability until the concrete reaches the required mechanical strength. Consequently, the engineering suitability of a formwork system cannot be evaluated solely according to its material strength but must also consider deformation behaviour, load transfer characteristics, and operational reliability during repeated construction cycles (ACI Committee 347, 2014; EN 12812, 2008).

Timber, steel, and aluminium exhibit substantially different structural responses despite serving the same engineering function. Timber provides satisfactory structural performance for low-rise construction and irregular architectural geometries because of its ease of fabrication and relatively low self-weight. However, variability in material properties, moisture absorption, and progressive deterioration reduce its dimensional stability after repeated reuse. Steel demonstrates the highest stiffness and geometric precision, making it particularly suitable for large-scale repetitive construction. Nevertheless, this superior structural rigidity is accompanied by increased self-weight, greater lifting requirements, and higher installation effort. Aluminium occupies an intermediate engineering position by reducing structural weight while maintaining acceptable rigidity, although its resistance to local deformation remains lower than that of steel under comparable loading conditions (Hurd, 2005; Chudley & Greeno, 2020).

Durability has become a decisive parameter in the engineering evaluation of reusable formwork systems because it directly influences structural reliability, maintenance requirements, and life-cycle cost. Unlike permanent structural members, formwork is subjected to repeated assembly, concrete casting, dismantling, transportation, and storage, exposing the material to cyclic mechanical loading, moisture, abrasion, and environmental degradation. Consequently, service life is determined not only by the intrinsic properties of the material but also by its ability to preserve structural integrity and dimensional stability throughout repeated construction cycles (ACI Committee 347, 2014).

Conventional formwork materials exhibit markedly different degradation mechanisms under practical construction conditions. Timber progressively absorbs moisture during concrete casting, leading to swelling, shrinkage, and surface deterioration that reduce dimensional accuracy and limit the number of effective reuse cycles. Steel provides substantially greater resistance to mechanical wear and repeated loading; however, prolonged exposure to humid or chemically aggressive environments accelerates corrosion unless appropriate protective measures are implemented. Aluminium offers improved corrosion resistance and lower maintenance requirements than steel but remains susceptible to local damage, surface wear, and deformation after prolonged use under demanding construction conditions (Hurd, 2005; Chudley & Greeno, 2020).

CONCLUSIONS AND SUGGESTIONS

Modern monolithic construction increasingly requires formwork systems that combine high structural performance, durability, rapid assembly, economic efficiency, and environmental sustainability. The present review demonstrates that conventional formwork materials, including timber, steel, and aluminium, have made substantial contributions to reinforced concrete construction; however, each material exhibits inherent limitations related to structural weight, corrosion susceptibility, dimensional stability, maintenance requirements, or service life. These limitations become increasingly significant as construction projects demand greater productivity, repeated reuse, and improved life-cycle performance.

The review further indicates that basalt fiber reinforced polymer (BFRP) composites possess several

engineering characteristics that make them promising candidates for the next generation of reusable formwork systems. Their high specific strength, low density, excellent corrosion resistance, favourable durability, and reduced maintenance requirements provide clear advantages over many conventional materials. At the same time, their lightweight nature offers opportunities to improve handling efficiency, reduce labour intensity, accelerate construction cycles, and enhance occupational safety during installation and dismantling operations.

Despite these advantages, the current body of scientific knowledge remains fragmented. Existing research has focused predominantly on the application of BFRP in reinforcement systems, bridge engineering, rehabilitation, and structural strengthening, whereas comparatively limited attention has been devoted to reusable formwork systems for monolithic concrete construction. Consequently, comprehensive engineering studies integrating structural mechanics, constructability, durability, economic performance, and sustainability within a unified formwork framework remain scarce.

References:

1. ACI Committee 347. (2014). Guide to formwork for concrete (ACI 347R-14). American Concrete Institute.
2. Bank, L. C. (2006). Composites for construction: Structural design with FRP materials. John Wiley & Sons.
3. Chudley, R., & Greeno, R. (2020). Building construction handbook (12th ed.). Routledge.
4. European Committee for Standardization. (2008). EN 12812:2008 Falsework—Performance requirements and general design. CEN.
5. Fédération internationale du béton. (2021). fib Model Code for Concrete Structures 2020. Ernst & Sohn.
6. Fiore, V., Scalici, T., Di Bella, G., & Valenza, A. (2015). A review on basalt fibre and its composites. *Composites Part B: Engineering*, 74, 74–94. <https://doi.org/10.1016/j.compositesb.2014.12.034>
7. Hollaway, L. C. (2001). Strengthening and rehabilitation of civil infrastructures using fibre-reinforced polymer (FRP) composites. Woodhead Publishing.
8. Hurd, M. K. (2005). Formwork for concrete (7th ed.). American Concrete Institute.
9. Sim, J., Park, C., & Moon, D. Y. (2005). Characteristics of basalt fiber as a strengthening material for concrete structures. *Composites Part B: Engineering*, 36(6–7), 504–512. <https://doi.org/10.1016/j.compositesb.2005.02.002>
10. Tam, V. W. Y., Tam, C. M., Zeng, S. X., & Ng, W. C. Y. (2007). Towards adoption of prefabrication in construction. *Building and Environment*, 42(10), 3642–3654.
11. Kim, T. H., Tae, S., & Chae, C. U. (2016). Analysis of environmental impacts of concrete formwork systems. *Journal of Cleaner Production*, 122, 64–72.
12. Pan, W., Gibb, A. G. F., & Dainty, A. R. J. (2012). Strategies for integrating prefabrication into construction. *Construction Management and Economics*, 30(2), 133–146.
13. Pacheco-Torgal, F., Jalali, S., Labrincha, J., & John, V. M. (2011). Eco-efficient concrete. Woodhead Publishing.

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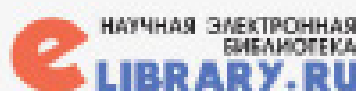
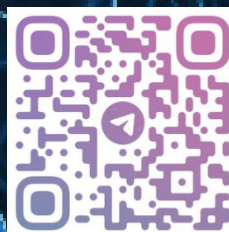
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