Sustainable use of recycled waste glass as an alternative material for building construction – A review

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Abstract. The construction industry requires the extraction of natural aggregates and cement in large quantities for new developments and maintenance of buildings and engineering infrastructures. However, extraction of these large quantities of natural resources has resulted in continuous depletion of earth’s natural resources which may lead to environmental degradation. Waste glass can be recycled as a replacement for natural aggregates and cement, therefore, reducing the amount of waste glass dumped in the landfill, and making exploration of natural aggregates unattractive and also reducing the emission of greenhouse gases in the atmosphere. Conversely, perception on using recycled waste glass for construction is that an increase in cost will be witnessed and may not be as effective as natural aggregates but with more sophisticated research this perception is declining. This paper reviews recycled waste glass, the standards, and sustainable uses of waste glass as a construction material. As the world population continues to increase, including an increase in the standard of living, the volume of generated glass waste will only continue to increase. However, it is important that we need to understand more about the use of recycle waste material such as glass in construction. The use of recycled waste materials in building construction is viewed as a sustainable way of managing wastes and preserving the environment from further degradation.

Keywords: Mechanical strength; Natural aggregates; Cement; Recycled waste glass.

1. Introduction

The principal target of waste recycling is to ultimately reduce the amount of waste that gets disposed of causing environmental nuisance [1-3]. Waste recycling has also been employed to provide alternative materials that facilitate the reduction in the depletion rate of natural materials, which are getting over-exploited. The natural materials used for the making of concrete are some of the materials that get easily depleted in the environment. Concrete is the one material in construction that is generally used, and it requires the utilization of recycled material in the mix [4]. All over the world, sand and gravel account for the highest amount of extracted materials. Of the global quantity of materials explored annually (between 47 to 59 billion tonnes), sand and gravel accounted for 68% to 85% of these materials [5].

The building construction and maintenance of civil engineering structures need a large weight of aggregates. A typical concrete mixture has about 90% by weight of aggregates. Considering, the amount of waste glass generated, a third is utilized in the generation of newly produced glass leaving the opportunity for it to be used in other applications [6]. Large amounts of glass waste are generated from many industries. Various industries globally reuse glass in different processes and as packaging material
or as storage. Table 1. Illustrates the recycling rates of selected countries. Germany showed the highest recycling rates as far back as 2004.

Table 1. An overview of selected countries and their waste glass recycling rate [7]

| Country    | Nigeria | Jordan | Germany | Turkey | Portugal | Sweden     | Singapore | USA       |
|------------|---------|--------|---------|--------|----------|------------|-----------|-----------|
| Waste Glass in(tons) | 2,088,000 | 35 building glass | 3,200,000 | 120,000 | 493,000 | 195,000 isolated 44,000 mixed | 72,800 | 11,500,000 |
| % Recycling Rate | 8.7 | 0 | 94 | 66 | 25 | 93 | 29 | 27 |
| Year       | 2108 | 2004 | 2003 | 2004 | 2001 | 2010 | 2010 | 2010 |

Sustainability of construction artefacts (buildings, bridges, dams, among others) is an on-going process which government legislation can also help to drive it. This influences the possibility to replace glass in concrete for distinct concrete mixtures, partially or completely. This reuse comes with many environmental advantages, including improving engineering design as regards to concrete mixes [4].

In construction management practices, the process of utilizing recycled waste glass in road construction has been established. The process absorbs aggregates and cement in larger quantities compared to building construction. However, with the issues of climate change, the world is being encouraged to decrease the number of extracted materials used in building construction and establish a position for alternative/recycled materials.

The major argument with the utilization of glass as an alternative material is that transportation and processing expenses of recycled waste glass into sustainable mortar and concrete mixes, has the tendency to be opposed due to cost implications. The expense acquired on transporting and formulating waste materials into viable properties must be defended by utilizing it in applications that are sustainable. Accordingly, the property prerequisites for these applications should guarantee that materials expected for reuse can meet significant specifications, by employing accessible innovations and facilities at a functional cost.

2. Glass

Glass is a part of everyday life for the vast majority and it is essentially a transparent frozen liquid and a combination of calcium carbonate (CaCO$_3$), soda ash and silica that is liquefied at extreme temperature. In order to avoid crystallization of the liquid it is allowed cool rapidly [8,9]. It is fabricated from abundant raw materials and can be promptly reused as feedstock in glass manufacture. Glass is infinitely recyclable with no loss of quality and value [10]. Glass forms part of the solid waste stream and in Nigeria, it is estimated that it comprises 8.7% of the waste stream [11,12]. Somewhere in the range of 80% and 85% of the mass yield from the overall glass industry is either as containers from the food, drink, and pharmaceutical companies, or flat glass for building development or for car production [9,13].

2.1 Glass Types and Waste Glass

Glass is comprehensively divided into three categories:

- **Soda-lime glass** ($Na_2O$, $CaO$, $6SiO$): It is principally a combination of sodium silicate and calcium silicate. It dissolves at low temperature and has no colour. In the mixed condition, it can be blown or welded effectively. It is utilized as windowpanes, for laboratory cylinders and instruments [14,15].
- **Potash lime glass** ($K_2O$, $CaO$, $6SiO$): It is primarily a blend of potassium silicate and calcium silicate. It is otherwise called hard glass. It dissolves at high temperature and is utilized in the production of glass objects which must withstand extreme temperature [15,16].
Potash lead glass (K$_2$O, PbO, 6SiO): It is, for the most part, a blend of potassium silicate and lead silicate. It retains a shiny gloss and incredible refractive power. It is utilized in the fabrication of synthetic gems, electric bulbs, focal lenses, crystals, prisms and so on [15]. Glass waste comprises of container glass, flat (or windscreens to touch screens) glass and the remaining type is called other glass, (this includes light bulbs, laboratory tubes). This discarded glass can be utilized as part replacement either as aggregate or cement. Insufficient infrastructure is the main reason glass waste is sent to the landfill. The unavailability of infrastructure makes the recycling of glass close to impossible. It is more economical to return recycled cullet back into the production of glass products in the glass industry because it saves energy, natural resources and it also reduces CO$_2$ emissions [10]. However, energy or natural resources might not be saved when glass is used as an aggregate unlike in the making of glass. It is when glass cullet cannot be used in the reproduction of glass that it is used as aggregate [10]. Most importantly recycled waste glass in concrete is another approach whereby waste glass is utilized, but with the likelihood of Alkali-silica reaction (ASR) because glass comprises of reactive silica with a high content (≥70%) of [17]. The advent of recycling of unused glass indicates that it can be utilized as a cementing material or as aggregate in concrete.

2.2 Uses of Glass
The adaptability of glass in the construction industry whether at home, work environment, and recent building structures must be energy efficient, safe, stylish and aesthetically pleasing; furthermore, comfortable for the inhabitants and can be utilized to produce energy and communicate [14,18]. Glass has infinite applications, but the following are some of its uses:

Thermal insulation: Insulated covered glass reflects heat from the structure and once more into the interior, so forestalling heat loss and assisting the relaxation of residents.

Solar protection: Glass can regulate the extent of solar energy infiltrating into a structure, permitting in light while reflecting part of the sun's warmth.

Health, Safety & Security: The glass utilized for this purpose safeguards against harm, shields property against vandalism, break-in and furthermore secures against outdoor sound, alone these lines protects the harmony and wellbeing of the residents. Lastly, antibacterial glass eradicates up to 99% of all microorganisms that interact with it, hence ensuring wellbeing.

Aesthetics: Spaces can be built with transparent, clear or in unpretentious tints. Translucent glass enlarges space; painted glass turns the space non-transparent and furthermore isolates spaces subsequently disseminating colour. Decorative glass carves the light. Reflected glass mirrors and enlarges space. For layered and coloured glass, it consolidates aesthetics with safety. Toughened and screen-printed glass assists in customizing building internal space. Electroluminescent (with LEDs) glass generates light and fanciful features. Designed and carved glass reacts to the innovativeness of furniture makers.

Energy generation: Building Integrated Photovoltaic (BIPV) glass has a twofold role, creating part of the external structure of the edifice, while in the meantime producing energy.

Communication and Infotainment: Laminated glass, integrating LEDs without noticeable wiring, during late night, converting structures exterior into coloured exhibitions or enormous screens with moving pictures.

2.3 Problems arising from the Use of Glass
There are large quantities of materials to make glass. Even though glass is recyclable there are issues emerging from the use of glass: it can break, it is costly to recycle and furthermore expensive to transport in view of its weight [9,13,14].

Amid the manufacture of production of glass, the fossil fuel consumption and the decline of raw materials lead to CO$_2$ emissions. During the process of manufacturing, carbon dioxide as the sole greenhouse gas is released. Nitrogen oxides (NOx) also contribute to acidification and the development of serious air pollution referred to as SMOG because of excessive dissolving temperatures as well as decomposition of nitrogen compounds in the batch substances.
Acidification can be caused by Sulphur dioxide (SO$_2$) from fuel burning and the decomposition of sulphate in the batch substances. Dissipation of liquefied glass during manufacture with other natural raw materials can then trigger particles to be released into the environment. The additional ecological and environmental challenges are contamination of water bodies, the utilization of unreplenishable natural raw materials, for example, sand and minerals, generation of solid waste and release of volatile organic compounds (utilized for the manufacturing of mirrors and coatings). Although a lot of emission reduction of SO$_2$, dust particulate matter, NO$_x$ and CO$_2$ has been achieved in the past few years, further reductions have been the vital environmental objectives of glass production companies. Curtailing and regulating these emissions in a coordinated manner is an intricate problem. The advancement of green techniques is continuous for progressive sustainability in the glass manufacturing sector. Notwithstanding, there are some negative effects that arise from the utilization of glass, but it has characteristics that other materials are not endowed [9,13 ,18].

3. Uses of Recycled Waste Glass
Recycled waste glass in concrete is often utilized in multiple methodologies in the building construction industry as partial substitutions of at least one or more of its constituents. Researchers investigated using waste glass as partial substitutions for fine or coarse aggregate, combined as fine and coarse aggregates, others used glass powder in partial substitutions of cement because of its pozzolanic nature [19].

3.1. Uses of Recycled Waste Glass as a Construction Materials
Reviews in the area of glass waste in construction have shown that recycled waste glass, when incorporated in concrete either in powder form or crushed as an aggregate, improved the mechanical strength of the concrete [4,20-29]. The type of glass powder analyzed and the colour influenced the compressive strength, lower values of strength was detected in green coloured glass that was partially replaced with up to 15% of cement [21]. In the case of 15% steady replacement, the supposed differences in compressive strength of the colour brown powder glass and the neon coloured powder glass were insignificant [21]. Increased strength of 13% from the experiment was observed for the neon coloured glass [21]. Neon glass has a high calcium (CaCO$_3$) carbonate content and this affects the compressive strength of concrete [21]. In a condition that there is no glass powder in concrete the mechanical properties act as follows, concrete with natural aggregates have significantly higher compressive and splitting tensile strength compared to crushed glass aggregates modified concrete [20]. Nonetheless, a number of studies have concluded that a mixture of 10% and a range of 15-30% of waste glass incorporated with concrete respectively, as fine aggregates or binder, will have no damaging consequence on the splitting tensile and compressive strength, respectively [4,22,24,27,29-40]. Calcium hydroxide above a 30% replacement becomes inadequate for the pozzolanic reaction because calcium hydroxide turns out to be inadequate when the replacement of glass powder is above 30% [27]. For resistance to water and chloride ingress, as a result of the bond and pore size glass powder with a high volume (the study highest replacement experimental value was 60%) of concrete is retained [27,33]. Waste glass that contains a huge amount of calcium and silicon can be described as amorphous in nature. Therefore, it can be claimed that it is pozzolanic or even cementitious in nature [31,35,41,42]. Recycled waste glass mortars detailed a low obstruction than standard sand mortars, with 15% recycled waste glass blend as the closest to conventional mortar [43-46]. The utilization of 10% glass powder as pozzolanic substitution redesigned the compressive strength of mortar at around 9.0% [39] All the more essentially, the utilization of 15% glass powder as bonding agent expanded cement compressive strength by an average of 16.0% and accomplished better results when compared as a replacement for cement [41].

The suitability of recycled heavy-weight waste glass as a fine aggregate was well thought out since it was found to expand the fluidity unit volume[27,47] when heavy-weight recycled waste glass is substituted[47]. The compressive and flexural strength of recycled glass mortar in any event is gradually decreasing as the heavyweight recycled waste glass is substituted in ratios [27].
In addition, the substitution of heavyweight recycled glass is fundamentally influenced by the size distribution micropore [47]. This expansion of glass affects the microstructure of cement especially paste/aggregate interface (ITZ) [27]. The incorporation of waste glass has prompted the improvement of the microstructure to about 21% replacement of fine aggregates. The mechanical properties of this type of concrete mix proportion are boosted [1].

Recycled glass compared to standard sand is less dense, and the absorption coefficient of glass is lower [44]. The strength improvement of glass powder in concrete mixtures is greater in the advanced stages [27]. It is recommended that initial ages when recycled waste glass powder are prepared it should be at miniaturized scale so that it acts more as a catalyst than a pozzolanic material (in light of Na$_2$O and the alkali contents) [27,48,49]. Hence, it very well may be required to have a slower quality improvement during an initial age [27]. The flexural strength of the recycled glass aggregate is of a comparable tendency with the compressive strength. The flexural strength increases as waste glass powder is utilized as a concrete binder or aggregate [27,47]. From day 0 to day 90, the flexural strength of mortar with the application of small increments by 21%-49% when glass powder is substituted by bond material; cement by 5%-25 %[4,27].

Concrete splitting tensile strength is impacted by the size of aggregate and binder material. Tensile strength increases as expansion occurs during of curing [50]. The source, of the particle size, the strategy for handling glass powder and mineral composition of glass changes, which may have diverse reaction components with the binder in concrete, in total concrete properties can be influenced [27,51]. In this context, workability has to do with the ease with which concrete is handled and it decides how effortlessly concrete will be shaped on site. Workability of concrete is determined by the slump test. The slump test is normally carried out at the batching point and when placing concrete on site. At the point when glass powder is replaced by mortar mixes no huge contrast is seen in the slump. In a few investigations, an expansion is recorded, because waste glass mixtures have a low water absorption rate. Then again, the impact of the recycled waste glass as cement replacement depends on the waste glass powder type.

Nonetheless, evaluation by partial replacement for sand and cement by waste glass powder as a fine aggregate or binder, the slump test estimation of concrete mix diminishes essentially. It is likewise seen that water absorption and water permeability are contrarily affected by the augmentation of waste glass in concrete [1,27]. Air void and compactor factors are fundamental to assess once the waste glass is utilized to replace the fine aggregates, a decrease in air void substance is observed for low substitution proportions (25%) however the expansion for high replacement proportions (100%) [1,27]. Therefore, was ascribed to two restricting effects: firstly, the particles of glass (utilized in the investigation) have a smooth surface appeared differently in relation to ordinary sand, bringing about better compression and less maintenance of air voids and secondly, glass particles likewise have progressively unpredictable form contrasted with ordinary fine aggregate (sand), bringing about the huge area that holds more voids [27]. At minimal substitution, the impact on air voids is reduce drastically while maximum substitution experienced increase in air voids [27].

In general, the parameters for bleeding and segregation can be expressed in increments with an expanding waste glass sand content [27,31]. Setting time (both initial and final setting time) of concrete containing waste glass increments as glass content increases. [27,52]. However, glass powder initiates hydration in cement paste. There are no huge changes in the setting time of recycled waste glass cement when 20% of waste glass powder is included in the sustainable paste. Portland cement partially substituted with recycled waste glass influences hydration. Hydration is profitable for counteracting initial age temperature

Calcium hydroxide reliably diminishes in the hydrated paste with higher glass powder replacement, especially when over 30% of cement was substituted by waste glass powder. In this way, the measure of waste glass warmth might be utilized as the cement paste replacement. The first recommended sum is 60%. Afterwards, it was found that (in view of the CH content) that the entire pozzolanic reaction may happen once the waste glass powder content is under 30-45%. Subsequently, waste glass is a
pozzolanic material with great potential. Truth be told, it displays pozzolanicity of levels equivalent to or more prominent than that of fly ash [26,27,53]. Durability qualities considered included alkali-silica-reactivity, electrical resistivity, chloride permeability and porosity this is enhanced with the adding of glass powders [23,28]. The improvement in mechanical strength and quantifiable durability of cementitious materials changed with glass powders and the increase of microstructure rising from the pozzolanic properties of attributed to glass powders[23]. The mixture of cement is impacted by the fine and angular surface territory of particles this implies that there is mechanical interlocking of glass particles, higher interest for water for better lubrication just as lower workability results to the presentation of extra super-plasticisers and stabilizers to accomplish the right consistency [4,20,27,31,55]. Young Modulus diminishes as the content of fine aggregates of glass powder surges. The clarification for the decline in elastic modulus is the innate physical attributes of glass, a weak network interfacial bond, and breaks in glass particles. Unmistakably, glass powder used as a binder impacts concrete properties as opposed to glass powder as sand this is relied upon to contrast in pozzolanic reaction constituents in its fine and coarse particles in cementitious material [27]. The elastic modulus of cement was upgraded to a level of 10.5 as glass cullet fine aggregate of a practically identical grading to natural fine aggregate was used. The accumulation of concrete begins with no adjustments in the association amid strength and modulus of elasticity. The creep of glass cullet fine aggregate concrete is additionally recommended to be equivalent to that of regular fine aggregate concrete [6]. SEM examination demonstrates that the crushed glass sand and cement have a delicate connection because of the voids made by the angular orientation of the aggregates. At the point when a waste glass is utilized as a (partial) substitution of fine aggregates a compact network forms. At the time a higher measure of waste glass is included negative impacts become prevailing this causes lower strength at higher waste glass rates. Pozzolanic reaction of glass powder experiences increments and prompts the generation of more C-S-H gel and an improved mechanical and durable glass powder concrete [4,27]. Combined use of thoroughly grinded glass powders all-encompassing crushed / pulverized waste glass aggregates has been examined on the premise that it strengthened utilization of powdered waste glass in concrete. The findings primarily linked the use of crushed waste glass aggregates in concrete to reactions associated to alkali-sílicas and essentially addressed the challenge. The investigation endeavoured to address mortar models containing pulverized waste glass aggregates and natural aggregate. Waste glass powders are utilized both as a cement substitution material and as an aggregate substitute. It is an extensively known fact that increase of waste glass in concrete mixes may activate Alkali-Silica Reaction (ASR) [27]. There is the expectation that concrete combining recycled waste glass is likely to influenced by alkali-silica reaction as a result of the extreme silica content generally in glass but with the observation that particle size will influence the occurrence of alkali-silica reaction; notably the coarse particles, partially dissolves in the process of hydration hence, fine particles most likely are fully used up during the pozzolanic reaction that commences just before the alkali-silica reaction. Glass powder was able to mitigate alkali-silica reaction significantly, as ground recycled glass was utilized as both aggregate replacement and as cement replacement [56,57]. Aggregate containing 100% glass material can be created without any harmful consequence of alkali-silica reaction if an adequate mix ratio of fine glass powder is applied[56]. On account of deformation as a result of dry shrinkage (the most critical), the recycled mortars indicated considerably more positive outcomes than the normal mortar, 100 % glass content had the least shrinkage rate in the exploratory stage[44-46]. Concrete shrinkage reduces at a rate which an emergent glass cullet fine aggregate substance, will give a 16% reduction at 100% substitution of basic fine aggregates. The impediment outcome is given by waste glass cullet fine aggregates in concrete impacted resulting in the nature of the concrete and water used to incorporate the fine aggregates [6].
3.2 Sustainable Use of Recycled Waste Glass

The literature review below is based on sustainable utilization of recycled waste glass. In order to improve clay properties, Soda, Lime Silica glass waste (SLS) is used by partially replacing clay to minimize the issues of dead load in high rise buildings. SLS glass waste is sintered at high temperature and it was detected that the utilization of SLS glass waste showed some positive influence on the properties of clay aggregates. It was recorded that strength increased, open porosity, waste absorption, and weight reduced [58].

- Translucent concrete is a state-of-the-art solution in accordance with considerably diminishing the requirement for non-natural lighting along these lines permitting the transmission of natural light into the internal section of buildings. Recycled glass is utilized as an aggregate to substitute of natural fine aggregate using self-compacting mortar (SCM). A substitution proportion of up to 30% recycled glass aggregate is practical for making of SCM and translucent concrete with great workability, adequate strength, and durability. The translucent concrete panels/ façade created in this investigation are appropriate for application in load bearing and non-load bearing architectural walls of green buildings, underground stations, in structural walls of banks, prisons, and museums to intensify security and supervision as well as safety [59].

- The evaluation was accomplished for recycled glass fly- ash geopolymer and was observed to be practicable for the generation low carbon masonry units with acceptable compressive strength [60]. The implementation consists of lightweight aggregates, used in buildings that involve load-bearing devices, floating structures or insulating materials, which have lowered thermal conductivity and improved mechanical characteristics.

- Waste glass was expanded and utilized as Yu, van Onna, Spiesz, Yu & Brouwers [61] stated: “Ultra-Lightweight Fiber Reinforced Concrete” (ULFRC). ULFRC implementation consists of lightweight aggregates, used in buildings that involve load-bearing devices, floating structures or insulating materials, which have lowered thermal conductivity and improved mechanical characteristics.

- Recycled waste glass was incorporated into the production of Hot Mix Asphalt and evaluated against the standard control Hot Mix Asphalt. The waste glass was in the form of crushed glass-bottles (cullet) and was utilized as fine aggregate for part substitution. Marshall Test (the optimum bitumen content, stability, flow, specific gravity, and air voids) was used to establish results and the Nigeria codes for roads and Bridges was the benchmark for Highway Standard. Results from this study showed that Recycled Waste Modified Hot Mix Asphalt was consistent with the Nigerian Codes for roads and bridges and Recycled Waste Modified Hot Mix Asphalt concrete behaved better than standard control Hot Mix Asphalt [62,63].

- Polymer concrete successfully was produced and used; it was derived from worn-out glass waste lightings collected from industries that use glass lighting elements. These lighting elements undergo the process of crushing to reduce the particle size so that it can be used as aggregates. The research was compared to conventional aggregated used in concrete [64].

- As’ad Munawir [65] Evaluated the significance of Alkali-Silica Reaction (ASR) phenomena in engineering structures in the long term considering different ways glass waste(cullet) is used in the form of fine aggregate or coarse aggregates.

- Green concrete innovations assist in improving the environment making use of recycled materials. The researcher studied the use of clay bricks powder and glass powder for use in concrete. The mix matrix substituted cement for the clay and glass powder to produce moderate strength concrete [66].

- The production of Geopolymeric tiles is a sustainable method of using waste glass powder. The tile constituents are a selection of waste glass like glass bottles, fluorescent lamps, other types of waste glass not mentioned. The tiles require an alkaline reaction to occur so as to initiate alkaline cementitious material. The compressive strength and ideal maximum load supported on Geopolymeric tiles are adequate for its application [67].
4. Conclusions

Saving the earth is a global issue and many stakeholders are looking for ways to limit energy usage and reduce the impact on the environment, research has observed that glass is a sustainable building constituent. The improvement in overall mechanical characteristic strength of concrete that had recycled waste glass in advanced ages was better than that of conventional concrete. Building construction is feasible and profitable medium to use recycled waste glass. Waste glass is preferable because total dependence cement is not sustainable due to its high emission of CO$_2$. However, engineering standards have to be introduced as a guideline for the application of recycled waste glass in construction. This control measure has the potential to make the recycled material more expensive to use than natural aggregates. The construction Industry is in the business to make profits, ensure long term durability of structures and it also has the corporate social responsibility of protecting the environment hence reevaluation for the reduction in the use of cement and natural aggregates in its operations due to environmental impacts. It will be in their best interest to find ways to incorporate the use of recycled glass without any detrimental effect on the industry profits and structural durability. Efforts to push waste glass to construction require continuous research and development. Research into cost analysis to affirm or refute the economic concerns of using waste glass in construction should be conducted. Glass waste utilized for construction will assist the reduction of the volume of waste glass that goes to landfill and furthermore represents the potential of decreasing the quantity of natural aggregates needed for construction. Processing and Transportation of waste glass into desired building construction resources may require a higher energy consumption and also experience increased emissions. This action defeats purpose of using recycled waste glass, so it is anticipated that a life cycle analysis will evaluate the effect of recycled waste glass on the structure and reports will be produced to assist with the adoption of recycled waste glass in the construction industry. Subsequently, so as to change the perspective on recycled waste glass as a constituent material in building construction the stakeholders through the government can offer rewards to the construction Industry emphasizing the great potential of using recycled waste glass in structures. Government should also enact legislation that promotes and encourages the utilization of recycled materials in construction. A number of factors affect the performance of structures that have recycled waste glass. Preconditions for utilization of recycled waste glass must exist and so be clearly stated: (1) The mix ratio, the component of each mix have different characteristic engineering properties on the constitute aggregates. (2) Glass shape, size of the particle and the mode of replacing glass content (optimum addition without detrimental effect is placed at 20%) [2, 7]. (3) Constituents, colour and mode of processing the recycled waste glass. Recycled waste glass can either be utilized as aggregate or cement. Moreover, in the perspective of the major technical concern of recycled waste glass in construction as regards to the impact of Alkali-Silica Reaction (ASR) in structures in-depth future research is mandatory.

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