

Effect Of Carbonation On The Microstructure And Moisture

The processing parameters of and processing procedures for sweetened blueberry flavored carbonated milk beverages were developed in this study. Foam formation of the milk after carbonation was controlled by a precharging of the vessel headspace. A combination of heat treatment (85°C, 30 minutes) and CMC addition was conducted to minimize the acid coagulation of casein with added fruit concentrate. Both carbonated and noncarbonated, sweetened blueberry flavored milk were evaluated by a trained panel. The effect of carbonation and sweetener source on taste properties in a blueberry flavored milk beverage system were discussed. Carbonation enhanced the sensory rating of overall intensity, sweetness and blueberry flavor. There was no significant carbonation effect on perceived viscosity. The sweetener source (sucrose, HFCS, pear concentrate and aspartame) caused a significant effect on the sensory rating of viscosity, but a nonsignificant effect on that of overall intensity, sweetness and blueberry flavor. Two consumer panels evaluated the carbonated, sweetened blueberry flavored milk beverages. The percentage of panelists who liked the products was approximately 50%. The results from the distributions of responses on a "just right" scale indicated that the carbonation and sweetness level probably were optimum formulations, and the level of blueberry flavor was too low. The results also implied that sucrose and HFCS were more appropriate sweeteners in flavored carbonated milk beverages than aspartame and pear concentrate. Two obstacles for consumer potential were the rapid separation phenomenon and the unattractive color of the products.

Sustainability is an important global issue nowadays, and it is known that production of portland cement is highly energy-intensive (embodied energy of OPC production is 5.3 MJ/kg OPC [1]) with a significant contribution to greenhouse gas emissions (0.97 ton CO₂/ton OPC [1]). While the absolute value of the embodied energy of OPC appears to be small, considering the large global consumption and production of OPC (annual world production of cement is 109 tons [2]) the negative environmental impact of OPC becomes evident. Therefore, many researchers have focused on development of Portland cement substitutes to produce a binder with a lower environmental impact. Alkali-activated binders, such as alkali-activated slag or fly ash (AAS or AAF) have shown to be promising alternative materials in fitting this purpose and can provide similar mechanical and fresh properties to portland cement. Slag and fly ash are industrial by-products, and their utilization in concrete, besides the added environmental values, will result in a more durable concrete in most aggressive environments compared to ordinary portland cement (OPC) [3]. Use of alkali activated slag binder and its potential to replace portland cement requires improvement in the knowledge of the durability aspects of this material. Carbonation of alkali-activated slag concrete is known to be higher than ordinary portland cement and can influence the long-term performance (durability) of this binder. Nevertheless, there are limited numbers of research focused on this issue. Carbonation is an important consideration in concrete durability, since it can promote corrosion of embedded reinforcement and disintegration of concrete matrix. The goal of this study is to investigate the mechanism of AAS carbonation in order to provide the means needed to develop a high performance and durable AAS concrete. It was found that the

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effect of carbonation depends to a large extent on the type of the activator. Carbonation rate of sodium silicate-activated slag was almost twice the carbonation rate of sodium hydroxide-activated slag (sodium silicate and sodium hydroxide are two commonly used alkaline activators). Additionally, while carbonated sodium silicate activated slag lost half of its strength during carbonation, the compressive strength of sodium hydroxide activated slag did not decrease after accelerated carbonation. The results were consistent with the observations in microanalysis techniques. When sodium hydroxide was used as the activator, carbonation products (calcite crystals) formed densely in the binder. For sodium silicate activated slag, deposition of crystalline calcium carbonate due to carbonation was not significant. The results also showed that natural carbonation in air softens AAS binder and leads to a higher shrinkage for AAS paste. Utilizing an NDT method to monitor carbonation progress in OPC and AAS, it was observed that microcracks develop during carbonation of AAS binder caused by C-A-S-H decalcification. The results showed that nonlinearity of sodium hydroxide activated slag uniformly increased by 90% during carbonation. For sodium silicate activated slag nonlinearity increased monotonically by 85% until carbonation reached its half, after which, the internal damage was beyond micro- damage measurement range of the implemented NDT method. In OPC, carbonation decreased the nonlinearity by 38% overall, due to transformation of portlandite to calcium carbonate.

Carbonated beverages are engineered to contain a defined quantity range of CO₂ dissolved into the product to optimize consumer preference. Carbonation level is an integral component of carbonated soft drink beverages that significantly contributes to positive sensory attributes of sodas; the mouthfeel and taste that the consumer expects. Rapid de-carbonation is a phenomenon in which the carbonation level of a canned carbonated soft drink beverage rapidly decreases to unacceptable levels, determined by consumer best taste limits, in less than 10 minutes of opening the can. Rapid de-carbonation leads to a range of negative experiences for the consumer. This phenomenon is classified into three types of rapid de-carbonation: gushing, foaming, and active. The objective of this thesis is to investigate factors that contribute to rapid de-carbonation through exploring the interactions between internal can coating morphology, beverage chemistry, and physical characteristics contributed by filling and processing conditions. Each of these factors has been studied separately in the past by the beverage, can, and coating industry. The factors were studied simultaneously to evaluate the effect on the rapid de-carbonation phenomena as well as the interaction between each factor. Specific levels, or conditions, of each factor were identified as a stress factor: high initial carbonation level, high water mineral content level, and a specific coating morphology. The results show that while each separate factor increased the rate of de-carbonation; however, when the stress factors were combined the effect was not only additive but synergistic. The carbonation loss increased by more than 1.5x when compared to a system that had lowest amount of engineered stress factors. Physical and chemical interactions between the beverage and coatings that were previously regarded as inert were observed. After the cans were filled, there were morphological changes in the can coating and deposits high in nitrogen were detected. These deposits were found to be more pervasive on the epoxy-based coatings versus the acrylic-based coatings. These findings can help the can and beverage industry better understand the interactions between beverage and packaging and how these interactions play a role

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in the widely elusive rapid de-carbonation phenomenon.

The study of carbonation perception is limited, even though carbonated beverages are very popular. A series of experiments were conducted to determine the sensory properties of carbonation itself and its interaction with other sensory modalities. First, the power functions of carbonation in carbonated spring water were developed by a trained panel using two assessing conditions, swallowing and expectoration. Five carbonation levels, 1.2, 2.0, 2.5, 3.0, and 3.9 volumes CO₂, were employed. The size of the exponents, 2.79 (swallowing) and 2.65 (expectoration), suggested a sharp increase of perceived carbonation magnitude with increasing concentration. There was no significant difference between exponents resulting from the two assessing conditions. Second, the effects of temperature on carbonation perception in carbonated spring water were determined by use of both a trained panel and a naive panel. Two carbonation levels, 2.4 and 3.0 volumes, and four temperature levels, 3°, 10°, 16° and 22°C, were employed. Carbonation intensity was perceived to be higher at lower temperatures than at higher temperatures. This effect held true for both trained and naive panels. The temperature effect on carbonation perception, however, was carbonation level dependent. Differences were more evident at the higher carbonation level. Thirdly, the mutual effects of carbonation and tastants (sweetener and acidulant) were determined by a trained panel. How CO₂ affects sweetness and how sweetener level affects carbonation perception were measured in both sucrose and aspartame sweetened systems. How CO₂ level affects sourness and how acid level affects carbonation perception were measured in both citric acid and phosphoric acid acidulated systems. The effects were measured at concentrations of 2-16% (w/v) for sucrose, 0.015-0.12% (w/v) for aspartame, 0.02-0.29% (w/v) for citric acid, and 0.015-0.06% (v/v) for phosphoric acid. Higher carbonation reduced sweetness ratings in aspartame-sweetened samples but had no effect on sweetness in sucrose-sweetened samples. Only the highest concentration of sucrose (16% w/v) reduced carbonation perception. Carbonation enhanced sourness ratings at the lower acid levels and had no effect at higher acid levels for both acid systems. No effect of acid level on carbonation perception was found.

This research deals with the carbonation phenomena in concrete for the first 28 days of the concrete curing period. The reactions known as carbonation are those which take place with the hydrated and un-hydrated components of the cement paste in the concrete mixture and the atmospheric carbon dioxide (CO₂). A literature review of the chemistry of cement and concrete as well as the physical phenomena of carbonation governed by Fick's first law and the influential factors in the carbonation reaction has been summarized. Moreover, information of different studies done at several conditions to measure carbonation rates, have been gathered and compared with the experimental results obtained in this research. Also, information regarding CO₂ emissions from the calcination reaction in the cement process was brought together in order to find out how much of the CO₂ emitted can be absorbed by concrete the first 28 days of the curing period. In order to study how is the process of concrete carbonation for the period of time specified, concrete specimens right after being poured in cylindrical molds, were exposed to accelerated carbonation conditions during 28 days, with controlled atmosphere of 5% CO₂ vol., 30°C and 65%RH. Products of the carbonation reaction in the concrete were measured versus time, with techniques such as Carbonation depth by phenolphthalein

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stain and Carbon Dioxide content by Thermo Gravimetric Analyses and Mass Spectrometry. Calculations of carbonation rate with phenolphthalein data and CO₂ absorption rates with TGA-MS data were done with the information collected. When phenolphthalein test and CO₂ content by TGA and TGA-MS techniques were used, the same tendency in the results was found; which coincides at the same time with formulations done by Fick's first law. The higher values of CO₂ content achieved by the concrete were consistent with the maximum availability of components to react within the concrete matrix. Similar results were found between the data obtained in the literature review, especially when laboratory set-up of accelerated carbonation conditions was simulated, and the measurements obtained in this experiment. Measurements done in here to find out carbonation rate showed that this value was smaller were compared with other studies in which the concrete was at normal atmospheric conditions of exposure. Results have shown that from data obtained by the different techniques used, the percentage of CO₂ absorbed during the first 28 days of the concrete curing period (with the specificities of the concrete used and the calculations done) goes from 0.34% to 1% of that emitted in the calcinations reaction of the cement process.

"Early carbonation curing of precast concrete products has shown better durability performance and excellent carbon storage capacity. In this work, the effect of early age carbonation curing on microstructure of cement paste as the CO₂-reactant in concrete was explored for Ordinary Portland Cement (OPC) paste to understand the mechanism. Following concrete-making procedure, OPC pastes were prepared with a water-to-cement ratio (W/C) of 0.36. The pastes were initially air-cured, then carbonated at 0.15 MPa, and, finally hydrated under sealed conditions after partially compensating for water loss by water spraying. Two carbonation durations (2 hours and 24 hours) were used for studying the microstructure. Analyses included X-ray Diffraction (XRD), Thermo-Gravimetric Analysis (TGA) coupled with Mass Spectroscopy (MS), Nuclear Magnetic Resonance (NMR) ²⁹Si, and Scanning Electron Microscopy (SEM). Results indicate that the evolution of carbonation can be distinguished into two steps. The first step occurs in first two hours when the pH is still high and entails the precipitation of near-amorphous to poorly crystalline calcium carbonate (CaCO₃) from a supersaturated solution. The CaCO₃ crystals serve as reinforcement for the calcium-silicate-hydrate (CSH), very similar in structure to CSH obtained from hydration. The carbon uptake was rapid and dominant in this period. The second step occurs when the pH starts to decrease due to prolonged carbonation. The ratio of HCO₃⁻/CO₃²⁻ in the pore solution is increased, and CaCO₃ crystals are allowed to grow inside the pores. The continued carbonation reduces the C/S ratio of CSH and transforms it into a structure having longer chains without cross-linking. This leads to a higher strength gain despite the low CO₂ uptake experienced in this period. The results suggest a diffusion-controlled kinetic model for carbonation. The pH value of the pore solution is maintained above the corrosion threshold even after 24-hour carbonation." --

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Developing economically feasible strategies for long-term storage of carbon dioxide has become over the past few years a major stake in response to the concerns over global warming. Carbon capture and storage (CCS) is widely believed to be one of the possible scenarios aimed in challenging the global warming phenomenon by targeting the atmospheric CO₂ content. Mineral carbonation - in the platform of CCS - is anticipated to be a premium option for permanent carbon capture and storage owing to the known reactivity of alkaline materials such as magnesium silicates and brucite with carbon dioxide to form stable and environmentally benign carbonates. Passive mineral carbonation of ultramafic mine waste and tailing minerals could be considered as an economically attractive option owing the availability of large amounts of magnesium-rich mining wastes, which are regarded to be virtually free, typically fine grained and highly reactive. Moreover, the energy input of nature is employed in passive mineral carbonation which is likewise free. In this way, CO₂ is mainly dissolved in water resulting from rain and snow season. Metal ions such as Mg²⁺ and Ca⁺ are also leached into the water allowing the formation of metal bicarbonate and consequently formation of metal carbonates. Laboratory experimental works were done in order to identify the dynamics of passive mineral carbonation under environmental conditions prevailing the Quebec region, Canada. A differential diffusion carbonation cell was developed to monitor the kinetics of mineral carbonation under ambient conditions. The kinetic measurements revealed the complex role of water both as reacting medium and moiety in the carbonation pathway. Time-dependent X-ray powder diffraction analysis and scanning electron microscopy reveal formation of transitional, metastable porous, flaky magnesium carbonates which subsequently evolved into less porous nesquehonite layers, which are shown to be responsible for surface passivation despite availability of unreacted brucite. However, surface abrasion was shown to liberate previously carbonated NIMT particles resulting in further carbonation on freshly exposed surfaces. Temperature dependent carbonation tests were performed in the ranges of hot (35 ± 1 °C), laboratory (23 ± 2 °C), low (5 ± 1 °C), and freezing (-5 ± 2 °C) to mimic different seasonal conditions. Temperature had a notable effect on the carbonation kinetics and lowering temperature caused a reaction slowdown despite carbonation is thermodynamically defined as an exothermic reaction. Moreover, it was observed that drying and freeze/thaw cycles were at the origin of a thermomechanical "peel-off" effect which inflicted micro-fractures to the carbonate product layers enabling water and gas to engulf beneath and react with freshly unearthed Mg donor sites. FTIR spectroscopy analysis revealed that hydrated magnesium carbonates such as nesquehonite are being formed parallel to brucite dissolution during mineral carbonation of brucite-rich nickel mining tailings. However, it was observed that nesquehonite is not the ultimate hydrated magnesium carbonate product. Long-term monitoring over 2 years of an already carbonated material revealed that the initial nesquehonite has evolved into dypingite and hydromagnesite depending on age, wetting/drying history and the depth where initial carbonate has been formed. Nonetheless, nesquehonite could maintain its stability over prolonged times if not being subjected to wet/ humid environmental conditions.

"Efflorescence is a salt deposit which is formed on or near the surface of a porous material such as Portland cement concrete.

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Although efflorescence is not an indication of internal damage, it alters the aesthetic quality of the product. The primary goal of this work was to investigate whether early-age carbonation can help reduce, or altogether eliminate, efflorescence formation on concrete paver blocks. The devised carbonation technique involved curing concrete pavers in a chamber filled with either pure or 20% carbon dioxide gas under a pressure of 5 bar. The carbonated pavers were evaluated by a newly developed test method to visualize efflorescence formation. It was modified from wicking test and was proven effective for the accelerated formation of efflorescence. A MATLAB-assisted image-analysis technique was used to quantify efflorescence severity. It was found that pure CO₂ curing seemed to be successful in eliminating the occurrence of efflorescence compared to the conventional hydration cured control specimens. Results from X-Ray Diffraction (XRD) and Scanning Electron Microscope (SEM) coupled with Energy-dispersive X-ray (EDX) spectroscopy identified efflorescence salt deposits as a crystalline potassium sulfate. Carbonation curing was able to reduce the efflorescence potential in two different ways. First, the curing process consumed the calcium hydroxide, the necessary chemical component for carbonate-based efflorescence. Second, the formation of efflorescence requires water to migrate up to the surface. Carbonation curing technique could densify the concrete surface and decrease the absorption consequently. Moreover, compressive strength results showed carbonation's advantage in achieving rapid strength gain. The carbonation process could reduce the production cycle, facilitate carbon storage in concrete and eliminate the efflorescence formation on the surface." --

Environmental impact on concrete parts of buildings results in a variety of unwanted chemical and chemically-induced mechanical changes. The bulk of these changes leads to damaging and destabilization of the concrete itself or of the reinforcement embedded in the concrete. One important destabilization factor is the drop in pH near the steel bars induced by carbonation of the alkaline constituents. This is caused by atmospheric carbon dioxide diffusing in the dry parts and reacting in the wet parts of the concrete pores. The phenomenon is considered as one of the major processes inducing corrosion in concrete. A particular feature of carbonation is the formation of macroscopic sharp reaction interfaces or thin reaction layers that progress into the unsaturated concrete-based materials. The deeper cause for the formation of these patterns is not quite clear, although the major chemical and physical reasons seem to be known. The main objective of this work is to understand the movement of internal reaction layers in order to be able to predict the carbonation penetration. We describe several relevant settings of the carbonation process by means of moving-reaction interface formulations. Non-local dynamic laws are used to model the advancement of the internal layers, which separate different modeling zones. We derive them via first principles for simple geometries using the physics and chemistry of the problem. The moving-boundary methodology essentially relies on these laws, which are usually descriptions of the velocity of the reaction front position. Specifically, the accuracy of the prediction is based on these supplementary relations and on a proper definition of the reaction front position. We investigate the competition between the non-linear carbonation kinetics effects, molecular diffusion and dissolution-precipitation mechanisms, which take place in the unsaturated concrete fabrics. Mathematically, the proposed models form coupled systems of semi-linear partial differential equations in two-phase moving

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domains. Non-linear transmission conditions of Rankine-Hugoniot type are imposed across the inner boundary that separates the carbonated regions from the uncarbonated ones. The movement of these regions is determined via non-local dynamics laws. Local and global existence, uniqueness and stability of the weak solution with respect to the initial data and parameters are shown. Useful upper and lower bounds, for instance on the velocity of the reaction front and on the time to complete the carbonation of a given part of a concrete sample, are obtained. Monitoring of such processes enables conclusions about the behavior of the moving-reaction front and can lead to a better prediction of penetration depths and of the corrosion initiation time. The moving-boundary methodology is illustrated numerically using experimental data extracted from the literature. The theoretical predictions compare well to the data from accelerated and outdoor tests. In particular, the agreement between the experimentally observed motion trajectory of the reaction front (i.e. penetration depth vs. time curves) and that computed via the proposed models is reasonable. Elevated levels of carbon dioxide in the atmosphere have created numerous environmental and socio-economic problems, including climate change. The scientific community is experimenting with various emission reduction and carbon capture and storage strategies. Mineral sequestration of carbon with alkaline industrial residues is one such emerging emission reduction technology which is being researched for its ability to be integrated into industrial plants, where both carbon dioxide (CO₂) and alkaline solid residues are generated on site. This concept can be applied to the coal-fired power generation industry, which produces enormous quantities of coal fly ash as a solid by-product along with massive emissions of gaseous CO₂ with the flue gas stream. Therefore, the mineral trapping of CO₂ with coal fly ash can help to sustain coal-based power generation, while bringing added advantages to fly ash disposal due to the favourable chemical changes which occur in fly ash during the above carbonation process. However, mineral carbonation to date remains an immature technology due to its main drawbacks related to kinetics and extensive research is necessary to find acceleration to accelerate mineral sequestration. The main aim of the present thesis is to investigate the effect of operational parameters on the accelerated carbonation of coal combustion fly ash and to study the effect of carbonation on the final disposal of fly ash, especially in relation to agricultural soil amendment. The research work is based on experimental studies conducted in the laboratory and in a greenhouse facility. The accelerated carbonation tests for fly ash were conducted in a newly-developed reactor facility in the Deep Earth Energy Research Laboratory in the Civil Engineering Department at the Clayton campus of Monash University. The main component of this facility is a continuously stirred cylindrical tank equipped with adjustable temperature and pressure mechanisms and monitoring and data acquisition systems. The fly ash materials were collected from the collection ponds of three major power plants located in the Latrobe Valley in Victoria, Australia. The carbonation reactions were designed to test the effect of reaction temperature (in the range of 20 °C to 80 °C), initial CO₂ pressure inside the reactor (in the range of 1 MPa to 10 MPa), water-to-solid ratio or solid dosage (in the range of 0.1 to 1) and the super-critical phase of CO₂. In addition, the effect of fly ash particle size was tested with five different particle size categories varying from

Carbonation is a naturally-occurring process whereby Ca-containing cement phases lose their hydration water and are converted to carbonate minerals by reaction with atmospheric CO₂. As these secondary minerals develop in the microstructure of hydrated cement, porosity, pore-size distribution and permeability are decreased. These are all considered desirable properties in a wasteform. The objective of this study was to examine the effect of carbonation and different pozzolans on the leach performance and mechanical strength of ordinary Portland cement (OPC) wasteforms. Two methods of accelerated cement carbonation were used: 1. A vacuum carbonation method, where

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wasteforms are placed in an evacuated, sealed cell and subjected to small additions of CO₂ over several days at near vacuum conditions; and 2. A one-step carbonation method, where CO₂ gas is added to the wasteform paste as it is being mixed. Thirteen elemental constituents of interest to the safety assessments of long-term management of Ontario Power Generation's radioactive waste (Cl, N, S, Se, ¹³C, Th, Pb, Co, Ni, Cu, Sr, Ba and Cs) were stabilised/solidified via cement mix water. Wasteforms were produced with only OPC, OPC and fly ash, or OPC and silica fume. Most wasteforms were carbonated using one of the carbonation methods. Some wasteforms were not carbonated and served as controls. Wasteforms were subjected to either standard leach tests or compressive strength tests. The extent of carbonation was found to be about 20% for vacuum carbonation method, substantially higher than that for one-step treatment (up to about 10%). For vacuum carbonated wasteforms, carbonation occurred at the outer selvages of the wasteforms, whereas one-step treatment resulted in homogenous carbonation. Generally, compared to uncarbonated OPC wasteforms, vacuum carbonation increased leaching of elements that are anionic in cementitious conditions (Cl, N, S, Se, ¹³C, Th), decreased leaching of large metal cations (Sr, Ba, Cs, Pb) and had negligible effect on the leaching of the elements that form hydroxyl complexes (Co, Ni, Cu). ¹³C was the only anionic element whose leachability was reduced by vacuum carbonation, as it may be precipitated in the form CO₃²⁻ in the large quantity of secondary carbonate minerals produced during the vacuum carbonation process. One-step carbonation did not result in substantial reductions in leachability, compared to uncarbonated OPC wasteforms. However, it had an interesting inverse effect on large metal cation leachability from fly ash- and silica fume-containing wasteforms. A model is presented that proposes that porewater pH changes can have an effect on waste element leachability because 1) the C-S-H Ca/Si ratio is dependent on the equilibrating porewater pH and 2) the degree of ion sorption on C-S-H is dependent on the C-S-H Ca/Si ratio. This model should be tested experimentally as it has important implications on wasteform design. Because of this inverse behaviour, overall neither pozzolan outperformed the other with respect to leachability. Generally, for uncarbonated wasteforms, OPC retained the elements more effectively than OPC with pozzolans. For pozzolans, the leachability of these elements from OPC with fly ash was lower than that of OPC with silica fume. Leaching of Cs was anomalously low from uncarbonated OPC wasteforms, but follow-up experimentation did not corroborate this anomaly. Further testing of these wasteforms to determine how the mineralogical fate of Cs can differ between wasteforms is recommended. All wasteforms tested were of acceptable strength (Thus the study of the effect of carbonation in the s/s waste is important for assessing the long-term effectiveness of the s/s treatment process. This research investigated the effect of carbonation on the leachability of toxic metals and the compressive strength of cement-solidified and geopolymer-solidified synthetic metal wastes. Synthetic sludges containing 0.1M copper nitrate, 0.1M lead nitrate, 0.1M chromium chloride, 0.1M zinc nitrate, 0.05M potassium dichromate and 0.1M cadmium chloride were mixed with ordinary portland cement (OPC) and fly-ash based polymers."--from Abstract.

Swallowing is a complex neurophysiological process involving the activation of several components of the central nervous system with bilateral but asymmetric representations of swallowing musculature in the motor cortex. Difficulty in swallowing (dysphagia) in stroke patients has been reported by up to 50% of victims, and can increase morbidity and mortality in this population due to the development of aspiration pneumonia and malnutrition. One of the common factors that predispose patients to dysphagia after a stroke is believed to be the reduced sensory awareness in the oropharyngeal area, which affects the swallowing process. The uses of diet modification to reduce thin liquid aspiration have gained interest but are often unpalatable or have limited success. Carbonated liquid have shown some beneficial effects in swallowing behaviour. However, there is very little evidence to support this intervention. Therefore, the aim of this thesis is to investigate the

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neurophysiological and behavioural effects of carbonated liquids on swallowing in healthy volunteers. The effects of carbonated solutions on swallowing performance compared to non-carbonated solutions (still water) was investigated in a pilot study and (still water and citric acid) in the main study using reaction time task (chapter 2). Carbonation appears to alter swallowing performance compared to other liquids by improving complex tasks. In addition, beneficial neurophysiological effects of carbonated liquids were evident after 10 minutes of carbonated liquid swallowing compared to still water and citric acid solution in healthy volunteers (chapter 3). In chapter 4, the response of the healthy swallowing motor cortex to carbonated liquids following application of a virtual lesion compared to still water and saliva swallowing, was investigated. Carbonated liquids were able to reverse the inhibitory effect induced by 1 Hz rTMS to the dominant pharyngeal motor representation. Moreover, the beneficial effects of carbonated liquids on swallowing performance, measured with a swallowing reaction times task after application of a virtual lesion was observed in a pilot investigation in healthy volunteers (chapter 5). These data demonstrate that carbonated liquids have beneficial neurophysiological and swallowing performance effects and support notion that the chemical properties of carbonated liquids may provide the required peripheral sensory information that alter the brain swallowing function, which leads to an improvement in the swallowing performance of stroke dysphagic patients. These data lay the foundation for considering the use of carbonation as facilitating stimuli in dysphagic patients.

To explore the carbonation effect on the design parameters of a bridge deck link slab made by ecological high ductility cementitious composites (Eco-HDCC), flexural and compressive properties of Eco-HDCC were studied. Besides, the carbonation front and pH profile in the pore solution of Eco-HDCC specimens with different carbonation ages were determined. Results indicate that the ultimate flexural strength of Eco-HDCC has little change as carbonation age increases, and first cracking strength increases for carbonation ages of 3 d?7 d, then decreases. The ultimate deflection of Eco-HDCC after being carbonated is higher than that of the virgin specimen. Besides, as the carbonation age prolongs, the compressive strength and elastic modulus of Eco-HDCC slightly increase. In addition, with the increase of the carbonation age, carbonation front of Eco-HDCC increases while the pH value of the pore solution decreases. When the depth ranges are 15 mm?25 mm and 37 mm?40 mm for carbonation ages of 56 d, the pH values are 10.4 and 11.2, which may destroy the passive film of the steel bar. Moreover, the mechanical property parameters for the design of the link slab made by Eco-HDCC can be selected according to non-carbonated material for the purpose of safe and conservative design. The corrosion-resistant steel bar or fiber-reinforced polymer (FRP) bar could be a promising choice to prevent steel bar corrosion.

"Carbonation curing of precast concrete has shown enhanced durability performance and carbon storage capacity. However, carbonation curing may reduce the pH of concrete. Furthermore, the progressive weathering carbonation in service may aggravate the problem, leading to the corrosion of steel in concrete. This thesis is to investigate the effect of early carbonation curing on concrete resistance to weathering carbonation. The concrete cubes were prepared with two water-to-cement (w/c) ratio: 0.65 and 0.40. The samples were initially in-mold cured, off-mold fan dried, then carbonated with pure CO₂ gas at 5 bars for 2 and 12 hours respectively, and finally subsequent by hydrated. To evaluate the degree of weathering carbonation, carbonation depth, carbonation coefficient, pH distribution, carbon content, and X-ray diffraction analysis were performed. It was found that the volume of permeable voids was lower in carbonated samples

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than in hydration reference, which was indirectly proved to be beneficial to decrease the permeability and porosity of concrete by carbonation curing. For concretes with $w/c = 0.65$, the carbonation depth, pH value and carbon content analysis were found to be more affected by weathering carbonation in 12-hour carbonated concrete than in 2-hour carbonated and hydrated concretes. Early carbonation curing even helped to reduce the carbonation coefficient in weathering carbonation. For concretes with $w/c = 0.40$, the carbonation depth, carbonation coefficient, pH value and carbon content of different carbonated and hydrated concretes were comparable during weathering carbonation. Therefore, the early carbonation curing was not more detrimental to precast reinforced concrete in this mix design over weathering carbonation." --

The market for carbonated beverages has grown dramatically over recent years in most countries, and this growth has required changes in the way factories are run. Like other food products, soft drinks are required to be produced under stringent hygiene conditions. Filling technology has progressed rapidly to meet the needs of manufacturers and consumers alike. Packaging choices have changed and there have been improvements in closure design. This book provides an overview of carbonated soft drinks production in the early part of the twenty first century, presenting the latest information on carbonation and filling methods. There are also chapters on bottle design, can making, general packaging considerations, production and distribution. A final chapter deals with quality assurance, and environmental and legislative issues. Detailed references provide opportunity for further reading in more specialised areas. The book is aimed at graduates in food science, chemistry, microbiology and engineering who are considering a career in the soft drinks industry, as well as technical staff already employed within the industry and associated suppliers.

The aim of the paper was to show the important aspect of treating waste additives as the main way to achieve sustainable development in the concrete technology. The author considers the effects of minimizing the use of cement replacing it with waste additives, on the concrete durability. The depth of carbonation is adopted as the possible measure of durability. Results of accelerated and natural tests of carbonation progress for concrete with normal and fluidal fly ash, silica fume and blast furnace slag are shown, influence on carbonation of the additive type, its content in concrete and its role (cement or aggregate substitution) is discussed. The important impact of early water curing on depth of carbonation is stated also.

"Alkali-silica reaction (ASR) is one of the principal causes of maintenance and rehabilitation in concrete structures. ASR is a reaction between alkali from cement and reactive silica from aggregates. The primary aim of this thesis was to investigate the possibility of ASR reduction or elimination in concrete by early carbonation curing. The secondary goal was to determine the optimum early carbonation exposure time that leads the highest strength and carbon dioxide gas

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sequestration in concrete. The effect of early carbonation curing on ASR expansion was assessed via length increase standard tests such as accelerated mortar bar test (AMBT) and modified accelerated mortar bar test (MAMBT). Spratt aggregates were used as alkali-reactive aggregates in mortar bar tests. Four batches were tested including moist hydration reference, air dry hydration reference, 2-hour carbonation and 18-hour carbonation. It was found that both 2-h and 18-h carbonation reduce significantly the ASR expansion. At 14 days, the expansion in carbonated mortar bar was 0.01-0.02%, considerably lower than the threshold value of 0.1% while the two hydration references experienced an expansion in a range of 0.32-0.35%, confirming that Spratt aggregates were reactive. ASR reduction by early carbonation is attributed to the facts that early carbonation converts calcium hydroxide, an essential compound in ASR reaction, to calcium carbonate, and the surface densification of mortar decreases water flow which is essential for ASR reaction. Moreover, the 112 days' compressive strength of mortar cubes is higher in carbonated samples (63.3, and 59.3 MPa) than that in hydrated references (46.3 and 41.9MPa), leading to more resistance to expansion induced cracking. The carbon dioxide uptake by 2h and 18h carbonation cured mortar bars were 15.8 and 22.8 %. It was indicative that early carbonation is effective in carbon utilization and sequestration. The carbonation duration has an effect on carbon uptake, but not on strength gain and the degree of ASR reduction. " --

This Digest discusses the carbonation of normal dense concrete which results from the reaction of atmospheric carbon dioxide gas with hydrated cement compounds. It relates particularly to the assessment of the risk of corrosion to embedded steel. The Digest describes the carbonation process and how the depth of carbonation can be measured. The high contribution of CO₂ emissions associated with pavements has driven research to assess the life cycle of concrete versus asphalt structures and to develop a strategy to reduce the carbon footprint. The life cycle of pavement has been studied with respect to CO₂ emissions in the use phase of concrete as well as after the concrete is demolished. However, only a few have considered the effects of CO₂ uptake in the carbonation process during the use phase, and even fewer have studied the effects of carbonation after demolition. This work fills the gap between estimates of carbonation in a life cycle assessment for pavements by considering the effects of the storage method on the uptake of CO₂ after the concrete demolished. It is observed that how the concrete is stored after demolition can have an influence on the CO₂ uptake of the structure. There is also an increase in the amount of the CO₂ emitted during the calcination process that is taken back up by the concrete structure during the carbonation process to a level of 6 - 30% from previously predicted values of 5-10% which assume no carbonation after demolition. The incorporation of carbonation after demolition into a comparative life cycle assessment between asphalt and concrete pavement is used to better predict the pavement material with the lower environmental impact considering variations in the climate zone, traffic level,

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maintenance schedule, design life and analysis period.

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