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EXPERIMENTAL STUDY ON AERATED LIGHTWEIGHT CONCRETE-A REVIEW

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Abstract — In the present paper, the effect of Aerated lightweight concrete on properties of concrete has been studied. In this study it is observed that Aerated lightweight concrete has many advantages when compared with conventional concrete such as advanced strength to weight ratio, lower coefficient of thermal expansion, and good sound insulation as a result of air voids within aerated concrete. Aerated lightweight concrete are classified into two categories are foamed concrete and autoclaved concrete. Also, considering the raw materials used in aerated concrete, types of agent, properties and applications. Properties such as porosity, permeability, compressive strength and splitting strength are also focuses on the aerated lightweight concrete.

Key words- Aerated concrete , wastes ,

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INTRODUCTION

Aerated concrete has the advantages of light weight, good performance of heat insulation, sound-absorbing effect is good, and has a certain strength and process ability, as the envelope of the filling and thermal insulation material, is widely used in building, valued in the world, the preferred building materials become many national promotion and development.

Aerated concrete is also well-known as a cellular concrete .It is divided into two main types according to the method of production. They are foamed concrete (non-autoclaved aerated concrete (NAAC)) and autoclaved aerated concrete (AAC). Foamed concrete (non-autoclaved aerated concrete (NAAC)) is produced by injecting preformed stable foam or by adding a special air-entraining admixture known as a foaming agent into a base mix of cement paste or mortar (cement+water or cement+sand+water). The Autoclaved Aerated Concrete (AAC) is produced by adding in a predetermined amount of aluminum powder and other additives into slurry of ground high silica sand, cement or lime and water. Foamed concrete have high flow ability, low self-weight, minimum consumption of aggregate, controlled low strength, and excellent thermal insulation properties. The density of foamed concrete has wide range (1600-400kg/m3), with appropriate control in the dosage of the foam, can be obtained for application to structural, partition, insulation, and filling grades.

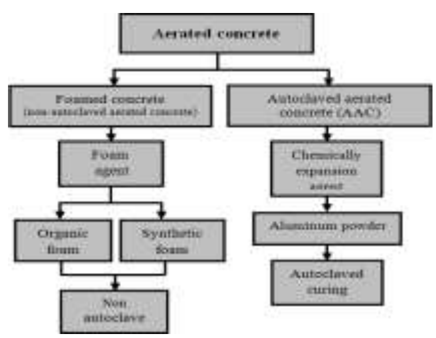

Fig 1. Classification of aerated lightweight concrete

LITRATUTE REVIEWS

Oksana Poznyak1, Andryy Melnyk2 [1] Studied "Non-autoclaved aerated concrete made of modified binding composition containing supplementary cementitious materials". In this paper author studied the impact of carbonate-containing and sulfate components, zeolite, polypropylene fibers on the properties of modified binding composition and non-autoclaved

aerated concrete based on them is investigated. The aerated concrete based on the modified binding composition containing a supplementary cementitious material, that of carbonate-containing salt waste, reinforced with polypropylene fibers is characterized by the compressive strength of 2.7 MPa with the density of 650 kg/m^3. The thickness of partitions

between pores is 0.16 – 0.21 mm, and the number of pores with the size 0.2-1.0 mm is 76.4%.

The author concluded that the use of salt processing wastes , has a positive ecological effect as

Wastes are recycled and on the other hand, it has economic and technical effects. Including up to 10 % mass of carbonate-containing salt wastes into binding composition provides the increase of cement stone early strength as well as that of later terms of hardening and the use of sulfate-containing wastes causes decrease of mechanical strength at all terms of hardening. Aerated concretes containing carbonate-containing salt wastes has better ability to retain gas, the evidence of which is shortening the time of aerated concrete mix growth from 21 min. to 12-14 min. and increasing the multiplicity of swelling on 5%. The addition of reinforcing components to the composition of aerated concretes, polypropylene fiber, in particular, improves the strength characteristics of aerated concretes. The aerated concrete based on the modified binding composition containing a supplementary cementitious material is carbonate-containing salt waste, and reinforced with polypropylene fibers is characterized by the compressive strength of 2.7 MPa with the density of 650 kg/m3 after 28 days of hardening. The thickness of partitions between pores is 0.16 – 0.21 mm, and the number of pores with the size 0.2-1.0 mm is 76.4%.

Melnyk A.Y0.$_1$, Poznyak O.R.$_2$, Soltysik R.A$_3$ [2] Studied, “ Non-autoclaved aerated concrete produced using industrial wastes ” In this experimental study Portland cement “Ivano-Frankivsk cement” with the following characteristics specific surface Sspec = 350 m2/kg is used. Fly ash from Burshtynska thermal power plant was used as a finely dispersed filler with the following properties , true density – 2.21 g/cm3 , bulk density – 870 kg/m3, chemical composition, as supplementary cementitious materials there were used salt processing wastes, such as carbonate containing and sulfate components with the following chemical composition, carbonate-containing component , sulfate component , Physical and mechanical properties of cementitious systems and aerated concretes based on them were determined by standard test methods.

The author concluded that-Application of salt processing wastes, on one hand, has a positive ecological effect as wastes are recycled and on the other hand it has economic and technical effects. Including up to 10 wt. % of carbonate-bearing salt wastes into composition of cementitious systems causes increase of cement stone early strength as well as that of later terms of hardening and the use of sulfate-bearing wastes causes decline of mechanical strength at all terms of hardening. Aerated concretes containing carbonate-bearing salt wastes have better ability to retain gas, the evidence of which is shortening the time of aerated concrete array growth from 21 min to 12 min and increasing multiplicity of swelling from 2.8 to 2.9. Introduction of reinforcing components into the composition of aerated concretes, polypropylene fiber, in particular, improves the strength characteristics of aerated concretes. The aerated concrete based on the modified cementitious system containing an additional cementitious material, that of carbonate-bearing salt waste, and reinforced with polypropylene fibers is characterized by the compressive strength of 2.7 MPa with the density of 650 kg/m^3 after 28 days of hardening. The thickness of partitions between pores is 0.16 – 0.21 mm, and the number of small pores with the size 0.2-1.0 mm constitutes 76.4%.

A. A. Costa[1], A. Penna[2], G. Magenes[3] and A. Galasco[3] [3] Studied, "Seismic performance assessment of autoclaved aerated Concrete masonry buildings". In this study autoclaved aerated concrete blocks are diffusely used worldwide as a construction material both for infill panels and load-bearing walls. In this Experiment very low weight of this material and its high deformability (low value of Young modulus in compression) is used to reduce inertia forces on the building induced by the seismic motion. In order to assess the seismic behaviour of entire AAC masonry buildings, a calibration of the nonlinear macro-element included in the TREMURI analysis program was carried out based on the experimental

cyclic response of masonry piers observed in tests performed at the EUCENTRE and University of Pavia laboratories. Also, several nonlinear static and dynamic analyses were carried out on complete building models, considering different structural configurations representative of typical Italian masonry building typologies.

The author concluded that- The calibrated nonlinear macro-element model correctly reproduced the cyclic tests results on AAC masonry panels regarding hysteretic behaviour and envelope of the response which permitted to assess the seismic performance of complete three-dimensional AAC masonry building models. Therefore the nonlinear adaptive procedure (SDAP) provided capacity curves well matching the nonlinear dynamic envelope curves in all analysed buildings, enhancing the capability of Galasco .In addiction to that, the suggested bilinear idealization of the response by Costa (2007) reproduced more accurately the displacement demand obtained with nonlinear dynamic analyses than the procedure drafted in Eurocode 8 (CEN, 2005). The results of AAC building seismic analyses point out that for 1-2 storey buildings and for low to medium levels of excitation (for rock sites), the damage limit state may not be attained. For higher levels of excitation, significant damage can be expected especially for multi-storey buildings. No direct correlation was found between % wall and buildings behaviour in the performed analyses but geometrical regularity in plan is suggested to improve AAC structures performance. The results obtained from adaptive pushover analyses (Actual Displacement-Based Adaptive Pushover) of the different prototypes have been compared with the results of incremental dynamic analyses.

Marian Pruteanu 1 and Maricica Vasilache $_2$ [4],Studied “Thermal conductivity determination for autoclaved aerated concrete elements used in enclosure masonry walls” . Author says where the climate changes effects are developing continuously, with a permanent intensification, the energy efficiency of buildings became a starting point in current building design. Also energy efficiency of a building is directly influenced by the thermal performances of the envelope. Therefore, designing of envelope elements whose global thermal resistance exceed the required minimum values, is a mandatory measure. For increasing thermal performances of enclosure mansonry walls, they use thermal insulating or by using masonry blocks with low thermal conductivity. This paper presents some experimental determination of thermal

conductivity for AAC blocks manufactured in there country. Furthermore, the equivalent thermal conductivity of an AAC masonry was determined by using an FEM software and mathematical calculus.

The author concluded that- The experimental measurements conducted of AAC blocks and masonry walls have highlighted a number of issues on the thermal performance of the material. Dry density of the blocks (390 kg/m3) and its thermal conductivity (0.11...0.135 W/m.K) was characteristics superior than the one of the common AAC blocks and recommend the tested blocks for exterior walls with good hygrothermal behavior. Dry density of the masonry wall determined is 440 kg/m3 for mortar joints of 3 mm thickness and 488 kg/m3 for mortar joints of 5 mm thickness, with 34.8%…27.7% . The Thermal conductivity of the AAC masonry walls is direct influenced by the mortar joints thickness, the volume occupied by the mortar and the thermal conductivity of the mortar. The obtained values by numerical simulation indicate that the tested AAC masonry walls have an increase thermal resistance, there by the thickness of additional thermal insulations, necessary to obtain the minimum global resistance is lower than in common external walls.

Jennifer tanner1,Jorge varela2, Matthew Brightman3, Ulises Cancino4, Jaime Argudo5, and richard klingner6 [5] Studied, "Seismic Performance and design of autoclaved aerated Concrete structural systems" .In this study to facilitate the use of autoclaved aerated concrete (AAC) in the US. That program focused on shear walls, the fundamental lateral force-resisting element of AAC structures. The first phase of the experimental program consisted of tests on a suite of 17 shear wall specimens (10 shear-dominated and 7 flexure-dominated) subjected to quasi-static, reversed cyclic, in-plane lateral loading with applied axial load to simulate gravity loading. A two-story, full-scale AAC assemblage specimen was then designed and tested as the culmination of the testing program. The assemblage specimen contained two flanged AAC shear walls and two AAC diaphragms consisting of untopped AAC panels oriented perpendicular to the direction of load in the first elevated level and parallel to the direction of loading in the second elevated level.

The author concluded that-Based on test results it has been proposed for the design of AAC shear walls made of masonry-type units or horizontally oriented reinforced panels. The proposed design procedures address flexural cracking, flexure-shear cracking, web-shear cracking, sliding shear, crushing of the diagonal strut and nominal flexural capacity. The proposed provisions are reliable, with low coefficients of variation (generally below 15%) and values close to or exceeding 1.0 for the ratios of observed capacity to the capacity predicted using equations based on the tested strength. The Two-Story AAC Assemblage Specimen met its required objectives. The shear walls conformed to the predictive models for flexural cracking and web-shear cracking. Damage did not occur in the AAC floor slabs or their connections to the walls, verifying that the proposed design provisions based on adhesion would produce a structure whose behavior was governed by the behavior of the shear walls. Although the Two-story Assemblage Specimen exhibited web-shear cracking, stable hysteretic loops were achieved. With the effects of sliding removed, drift levels exceeded 0.3%, and displacement ductilities ranged from 2.5 to 6. For design purposes, these results justify the assumption of an available

displacement ductility of at least 2.5. Based on previous tests of flexure-dominated AAC shear walls ,this ductility would have been increased if the anomalous web-shear cracking had not occurred .This test confirms that the design objective of flexure-dominated behavior can be achieved even in relatively squat walls.

Kadir Güçlüer1 ,Osman Ünal2, İsmail Demir 3, M.Serhat Başpınar 4 [6] Worked“ An Investigation of Steam Curing Pressure Effecton Pozzolan Additive Autoclaved Aerated Concrete” .In this Study Autoclaved Aerated Concrete (AAC) is a porous light weight concrete is obtained by adding a pore-forming material to a mixture made of finely pulverized siliceous aggregate and inorganic binder (lime and/or cement) and hardened by steam cure. In this experiment fly ash was used instead of siliceous aggregate and experiment samples were obtained by adding 3%, 6%, 9%, 12% silica fume to the cement. Samples were cured under 156^0c and 4 bars and 177^0c and 8 bars, and were investigated for compressive

strength, bulk density and ultrasound pulse velocity to determine their mechanical and physical properties. Microstructure of samples was observed by using scanning electron microscope and XRD techniques.

The author Concluded that-Fly ash-cement-lime system samples were produced, similar physical and mechanical value results with the commercial aerated concrete were obtained. In the microstructure exploration of silica fume added aerated concrete, structures closer to cement paste were observed. In addition, there were structures who look like weak tobermorit plates and which were seen in specific areas. When XRD results obtained at the end of autoclave curing are compared to the mineralogical analysis of the commercial aerated concrete samples, it is seen that the tobermorite phase which is important for compressive strength does not evolve well. This result indicated the need for refinement of hydration conditions. This refinement would occur with high pressure autoclave usage. Where by this may enable the reduction of cement usage and improve the durability of the product. Additionally re-usage of raw materials in production would provide values to the economy of the country

Andreas Stumm [7] Studied, “Cement and sulphate free autoclaved aerated concrete” .In this study a project was launched at Xella to reduce the sulphate content in AAC to almost zero. For this, biggest source of sulphate besides cement is the pure calcium sulphate, which is added either as gypsum or anhydrite to the mixture.Addition calcium sulphate has been used in AAC to improve its material properties for many years. Technological solutions and recipes were use to produce cement and sulphate free AAC with low bulk densities in moluds with the size of 5.4 m^3.

The author concluded that-Sulphate AAC with low bulk density is not yet being made in mass production. Cement and sulphate free AAC cakes tends to collapse either in the demoulding or autoclaving process, and especially low densities are difficult to process. The Shrinkage tests shows values under 0.20 mm/m according to DIN EN 680.It Shows that cement free recipes lead to fewer transportation damages due to less brittle surfaces.

N. Arreshvhina1, Z. Fadhadli2, H. Mohd Warid3, A.H. Zuhairy4, Roswadi5 [8] Studied, “Microstructural behavior of aerated concrete containing high volume of GGBFs” .In this Study author said that Aerated concrete is a lightweight engineering material, which is produced by introducing air bubbles into normal concrete. Their properties depend on their internal structures, and also vary tremendously with age, curing, and also not forgetting the ratio of constituent materials. In this paper reports of compressive strength and microstructural changes are in two types of aerated concrete mix, exposed to various curing conditions. The two types of mix is one with 100 percent OPC (MCTR), while the other one with 65 percent slag replacement (M65). This specimens were cured in air, seawater, and natural weather for the period of six months. The compressive strength was tested at 14, 28, 90, and 180 days, while micrograph of the internal structure were taken at the age of 14, and 180 days. The micrograph was taken using scanning electron microscope (SEM).

The author concluded that-The microstructural alterations, either due to compositional variation (100 percent cement or slag cement based) or curing conditions (air, seawater or natural weather) significantly affects the properties of aerated concrete. Aerated concrete with sand and slag exhibits considerable difference in structure because of the relative variations in degree of hydration with time. The compressive strength of air-cured and natural weather exposed sample is much higher compared to sample submerged in seawater.

Presence of slag in aerated concrete increases the compressive strength by eight to 63 % compared to the aerated concrete without slag. However, the percentage differs according to exposure conditions. High content of slag improves the strength development of aerated concrete, as well as forms better microstructure.