CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses on the history on the autoclaved aerated concrete. The introduction and application of this type of concrete is important in civil engineering, so we will look in this chapter how did others classified and explained about autoclaved aerated concrete. The scope of this research is explaining the properties, characteristic, and comparing between the autoclaved aerated concrete and the ordinary concrete.

2.2 Autoclaved aerated concrete (AAC)

2.2.1 History

The aerated concrete is a one of the types of lightweight concrete. And it is known as a cellular concrete [1], the production of AAC (Autoclaved aerated concrete) is by adding the amount of aluminum powder and other types of additives into slurry of ground high silica sand, cement or lime and water [2], [3]. The background of AAC which is began 100 years ago. In 1914, the Swedes first discovered a mixture of cement, lime, water and sand that was expanded by the adding aluminum powder to generate hydrogen gas in the cement slurry [4].

2.2.2 Materials

Aluminum powder is usually used to maintain AAC by the reaction of chemicals generating in fresh mortar gasses so that when it settles it contain a huge amount of gas bubbles [5]. Aluminum is used in AAC production as a foaming component worldwide and it is proven that it's the best solution for this purpose. When it's added (usually at about 0.2% to 0.5% by dry weight of cement) to the mixing ingredients [6], the Aluminum powder can be categorised into three types: atomized, flake and granules. The atomized particle, its length, thickness and width are all of approximately in same order where the length or width of a flake particle maybe hundred times it thickness. In AAC industry Aluminum powder is made from foil scrap and exists of microscopic flake-shaped aluminum particles. . The production of AAC needs aluminum powders that contain fractions finer than 100 or 50μm. It's important in order to gain the required mechanical properties of the autoclaved aerated concrete [6].

The autoclaved aerated concrete raw materials are fine grading materials such as quartz sand, lime, aluminum powder and cement are the main important raw materials for AAC. Sand's percentage is having the highest amount than other aggregates in aerated concrete mix. Quartz sand is mineral based aggregate which can be obtained from broken rocks or granites. At the same time fly ash can be considered as aggregate [7].

Fine aggregates such as quartz sand and lame are combined with cement then hydration will start by adding water into it forming a bond between cement paste and aggregates. Moreover, expansion component (Aluminum powder) is added to the mix to increase its volume and the rang of increment can be from 2 to 5 times more than original volume of the paste. This material reacts with calcium hydroxide which is the product of reaction between water and cement. This reaction between calcium hydroxide and aluminum powder causes microscopic air bubbles which results increasing of pastes volume. The hydrogen that is formed is replaced by air which will be denser gas that enters into the mix. Depending on the amount of aluminum powder the volume increases. [7], [8]. Less expansion will produce higher strength which also will be more dense [7],[8]. Autoclaving is a process whereby the concrete is cured in a chamber with high temperature and high pressure for a specific amount of time. The range in the pressure is

(4- 16MPa) and duration is (8-16 hours) of the autoclaving process is used. The table shows the properties of AAC concrete [9].

Table 1: Properties of Autoclave Aerated Concrete [9]

Dry density	Compressive strength (Mpa)	Flexural strength (Mpa)	Modulus of elasticity (E-value) (GPa)	Thermal conductivity (3% moisture) (W/mK)
450	3.2	0.65	1.6	0.12
525	4.0	0.75	2.0	0.14
600	4.5	0.85	2.4	0.16
675	6.3	1.00	2.5	0.18
750	7.5	1.25	2.7	0.25

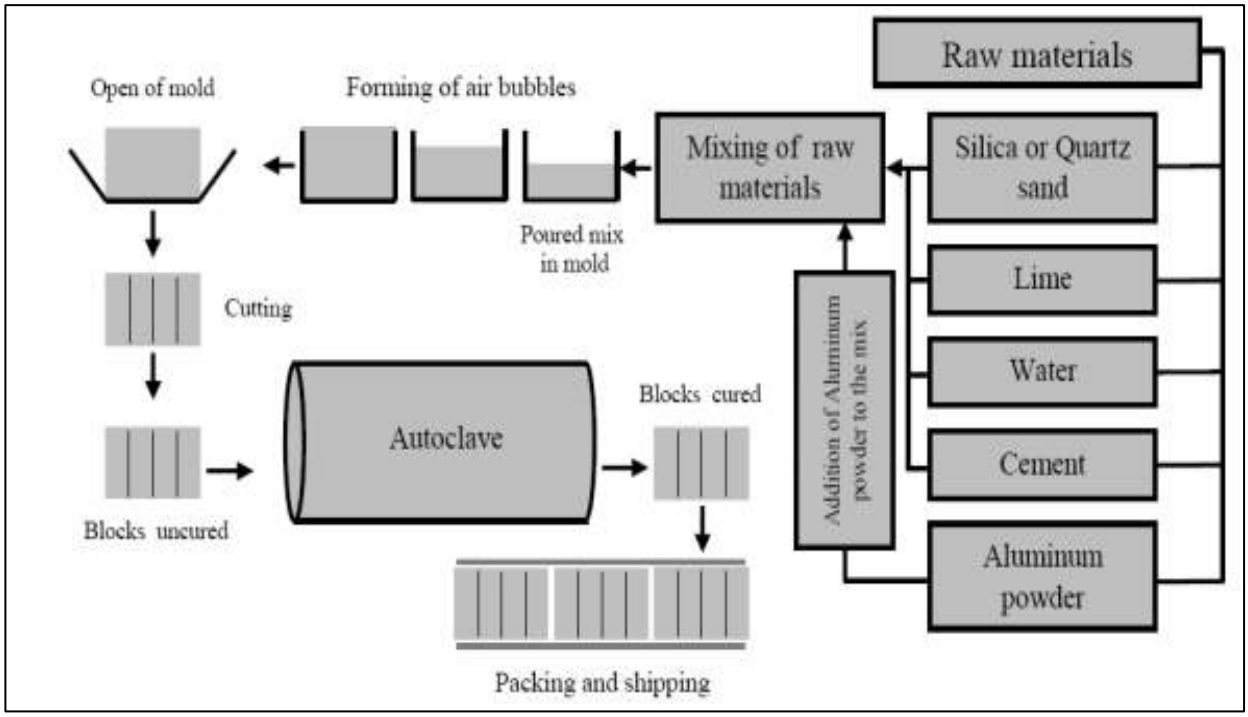

Figure 1: Process of Autoclaved Aerated Concrete production [12]

2.2.3 Properties:

Porosity (Air – Voids) and Permeability:

Gel pores, capillary pores and macro pores are classified from the cement – based materials due to deliberately entrained air and inadequate compaction. The gel pores dose not effect on the strength of concrete through its porosity. Moreover these types of pores are directly related to shrinkage and creep. Capillary pores and other large pores are responsible for lowering the elasticity and strength etc. [11]. Aerated concrete have higher strength when the air-void was narrower distributions shows. The fly ash may be used as filler to help in achieving more uniform distribution of air-voids by providing uniform coating on each bubble and thereby prevents merging of bubbles. At higher foam volume, merging of bubbles results in wide distribution of void sizes leading to lower strength [12]. Two researches have investigated the air void parameters like: size, spacing and volume of air voids to study the attitude on density and strength [11].

When the fluid is passing through a porous medium under the pressure action it is known as permeability and in the same time it's a flow property [2]. The aerated concrete permeability is influenced by the size, type and distribution of the pores, but the volume pore is not including. The classification of pores is in two types; open pores which connect to the outer surface of the material and closed pores are terminated from the outside boundary and containing fluid. The permeability of aerated concrete is participating in the open pores not in the closed pores [2]. Closed pore materials are mainly used for thermal insulators and sonic or low-specific gravity structural components [4]

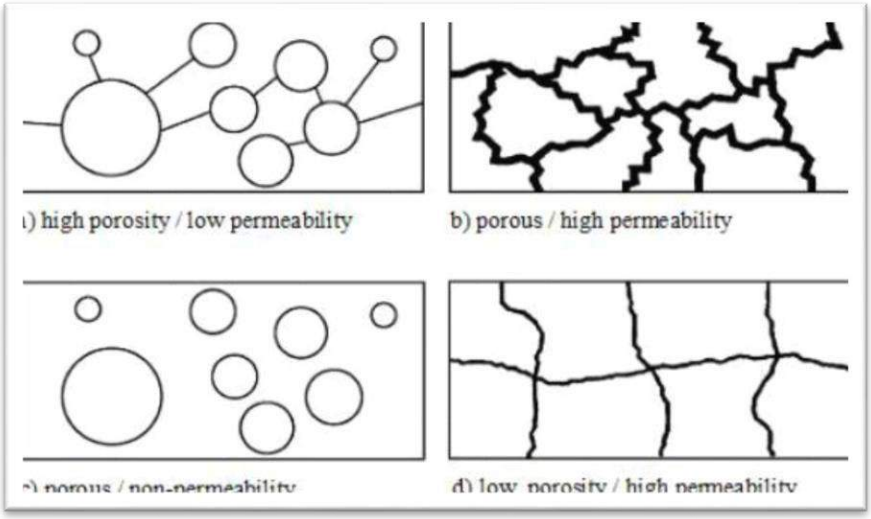

Fig. 4 shows the differences between porosity and permeability [2], Figure4.

2.2.4 Advantages and applications of aerated lightweight concrete

Comparing between the traditional insulation materials and cellular concrete the cellular concrete is more durable especially when it is considering potential chemical/fire exposure like in process facilities [13]. There are advantages of lightweight concrete it is having higher strength to weigh ration, tensile strain capacity is better, lower coefficient of thermal expansion and enhanced heat. Also, the sound insulation characteristics due to the air voids in concrete [14], [15]. Decreasing in cross- section of concrete structural elements (beams, columns, plates and foundation) is from the reduction in the dead weight of the construction materials by using lightweight concrete. And also, the reduction of dead load can reduce the load which is transmit to the foundation and bearing capacity of the soil [4], [16]. Lightweight concrete can be suitable for different parts of building; it can be used for load bearing and non-load bearing walls [17]. In construction engineering autoclaved aerated concrete blocks can be applicable in (pipeline backfilling, compensation for the foundation, insulation for roof, etc.), and also some application results in infrastructure facilities like (bridge and culvert backfill, widening of road, resolving bumping at bridge-head of soft base embankment [18].

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