limestone fines to produce sustainable crushed sand concrete with a strength and durability (Figure 4 and Figure 5) similar to that of concrete made with natural sand (Kenai 1999, Menadi 2009, Menadi 2011). The results of this investigation as well as that of other researchers have made it possible to modify local standards, which now accept up to 15% fines in crushed sand for reinforced concrete. Currently, most construction sites in the north of Algeria and, in particular, ready-mixed concrete plants use crushed sand.

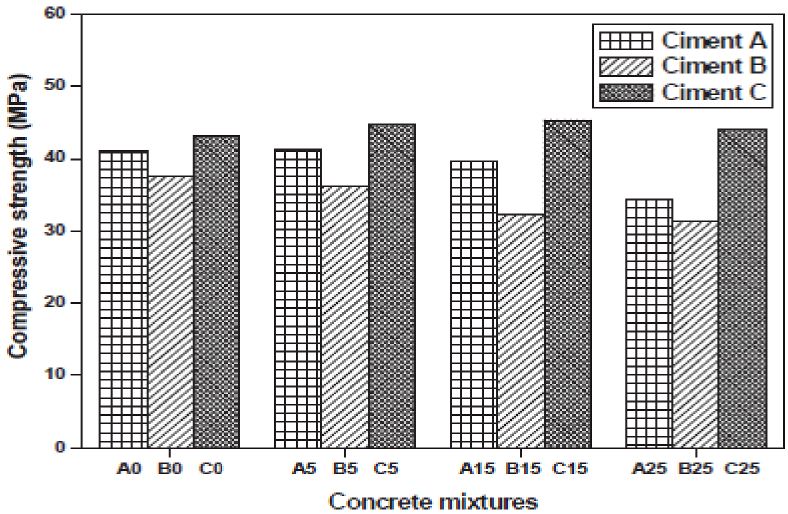

Fig.4 Compressive strength for concrete mixtures with different type of cement (MENADI 2011)

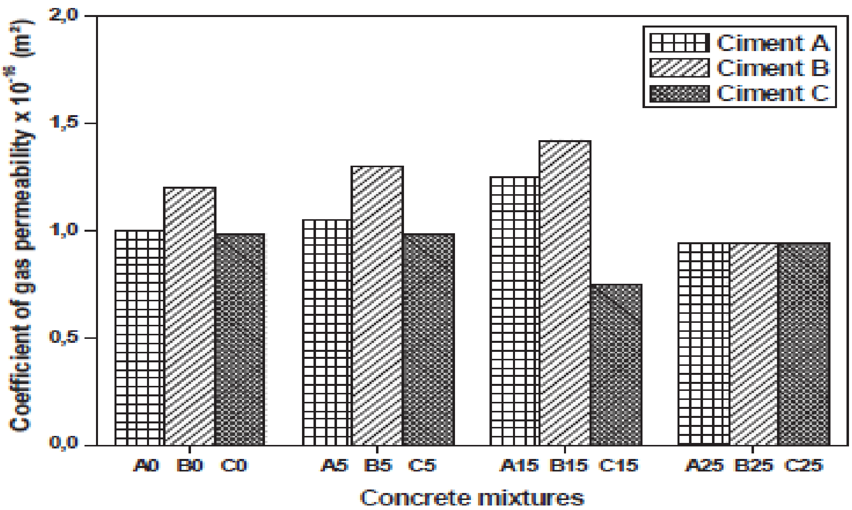

Fig.5 Gas permeability for concrete mixtures with different types of cements (MENADI 2011)

4.4 Strength and Durability of Self-Compacting Concrete

Self-compacting concrete (SCC) has been successfully used in many construction projects, mainly in structural members with complex forms and heavily congested reinforcement. It is a highly flowable concrete with minimal segregation that can flow into place under its own weight and compacted without any external vibration. This later could be obtained by the use of high amount of fine fillers (cement and mineral admixtures) in order to avoid aggregate settlement. The use of SCM is well accepted because of its improvement of concrete properties and also for environmental and economic reasons. The influence of Algerian slag on the properties of fresh and hardened SCC has been investigated (Boukendakdji 2009, Menadi 2012). The fresh properties of SCC were determined using slump flow, V-funnel flow time, J-ring, U-box filling height and geotechnical test method sieve stability tests. An optimum slag content of 15% seems to give a good SCC mixture with workability retention of about 60 minutes. A decrease in compressive strength was obtained with an increase of slag. Some applications of this by a local construction company are underway in slabs, bridges piers and foundations. Menadi (2013) examined the effect of using slag with different fineness to partially replace the cement in SCC and found that the strength and shrinkage of concrete are reduced with increasing amounts of slag whatever the fineness used (Figures 6 & 7).

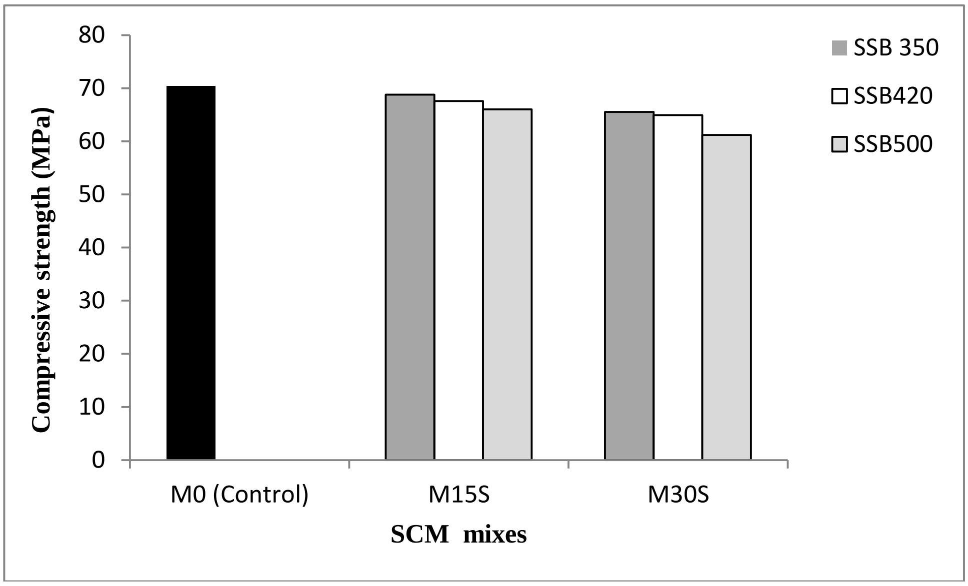

Fig. 6 Compressive strength of SCC containing slag with various finenesses (MENADI 2013)

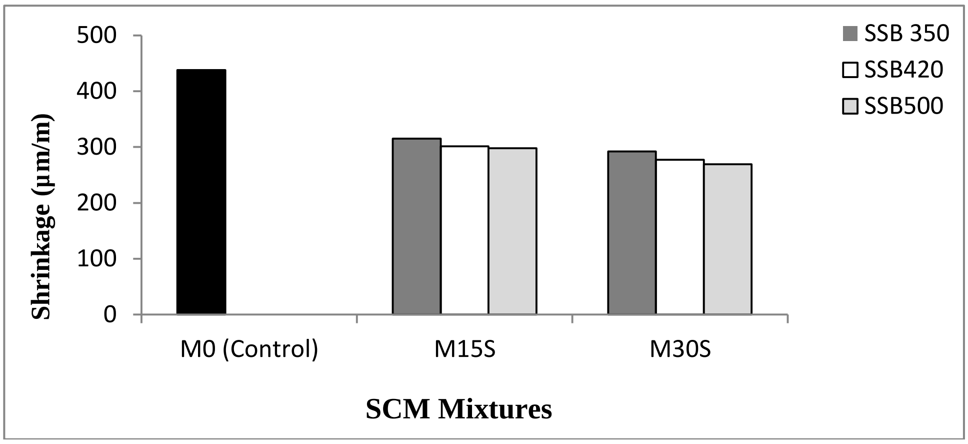

Fig.7 Shrinkage of self-compacting mortar mixes with slag (MENADI 2013).

4.5 Use of Waste Cork for Insulation

The development of materials from waste wood is an interesting alternative to save energy and to preserve the environment. An experimental study was conducted to develop a cement composite insulating material from cork waste (Kenai 2007). The experimental study deals with expanded and raw cork mixed with cement in ratio Cement/Cork by volume (C/L) = 1/1, 1/2 and 1/3. Preliminary tests to optimize the mix were carried out. The physical, mechanical and thermo-physical characteristics of this composite material were then studied. The feasibility of the composite material was investigated by fabricating blocks to which cement rendering was applied and the bond between these blocks and the cement rendering measured. The use of waste cork as the only aggregate in concrete has given a composite material with bulk as low as 614 kg/m^3. The results indicate a good compatibility between cork and cement. The compressive strength varies from 2 to 15 MPa and the flexural strength varies from 0.56 to 3.20 MPa. The coefficient of thermal conductivity was low and varied from 0.19 to 0.34 W/m°K. The thermal conductivity obtained is lower than that of foam concrete, autoclave concrete and gypsum and is comparable to that of cellular concrete, expanded clay, fired bricks and clay foam. However, water absorption by capillary and by immersion was high. The composite with expanded cork has a better mechanical performance than that with raw cork. Nevertheless, the composite with raw cork has better insulating and acoustic performances. The possibility of using this composite material in roof insulation and as partition walls is proved.

4.6 Cement Stabilized Soil

Earth construction is widespread in desert and rural areas because of its abundance and cheap labour and could be an alternative sustainable construction material for low cost housing in Algeria. An experimental study was conducted to optimize the compaction of the soil stabilized and improve physical and mechanical properties (Bahar 2004, Kenai 2006). The improvement of stability in water and the reduction of the withdrawal by the strengthening of the earth by the straw have also been demonstrated (Bouhicha 2005).

5. CONCLUSIONS

The concrete industry is the largest consumer of energy and natural resources and hence contributes heavily to environmental degradation. In order to get a sustainable construction that is environment friendly, there is a need to use local materials and low-energy-based materials. The use of recycled aggregates and other recycled materials such as cork, limestone fines is an alternative solution and should be encouraged at the design stage of a project. The use of cement replacement materials such as slag and natural pozzolana in vibrated and self compacting concrete should be encouraged as they reduce carbon dioxide emission and give durable concrete.

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