Studyon mechanical behaviour of Concrete Blocks by partialreplacement for PFA and Malwa waste

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ABSTRACT
Concrete is the third largest material consumed by human beings after food and water as per WHO. Concrete plays a vital role in the design and construction of the nation's infrastructure. Almost three quarters of the volume of concrete is composed of aggregates. These are obtained from natural rocks and river beds, thus degrading them slowly. This issue of environmental degradation and need for aggregates demands for the usage of any other alternative source. Global warming is the major concern that makes so many changes in our climate and destroys the ozone layer, which become dangerous to the living beings. Availability of sand is also rare, in order to overcome this causes we have to find better replacing ideas. The cement is partially replaced by Pulverized Fuel Ash and sand is partially replaced by Malwa Waste. Mix proportion is based on IS mix proportion ratio. Specimens are casted and the strength is to be determined for 7, 14, 28 days respectively. The specimen casting and test results are executed in this phase.

1. Introduction

Now days, hollow concrete blocks and bricks are becoming very popular. These blocks are being widely used in construction of residential buildings, factories and multi-storied buildings. These hollow blocks are commonly used in compound walls due to its low cost. These hollow blocks are more useful due to its lightweight and ease of ventilation. The blocks and bricks are made out of mixture of cement, sand and stone chips.Hollow blocks construction provides facilities for concealing electrical conduit, water and soil pipes. It saves cement in masonry work, bringing down cost of construction considerably.

A concrete block is primarily used as a building material in the construction of walls. It is sometimes called a concrete masonry unit (CMU). Many other types of buildings such as garages, silos, and post offices were built and continue to be built today using this construction method because of these qualities.

1.1 Market Survey and Strategies

Use of recycled coarse aggregate in concrete can be useful for environmental protection and economical terms. Recycled aggregates are the materials for the future. Same as pulverized fuel ash is also a by- product from various industries. Fly ash is a group of materials that can vary significantly in composition. The advantages of using pulverized fuel ash far outweigh the disadvantages. The most important benefit is reduced permeability to water and aggressive chemicals. Properly cured concrete made with fly ash creates a denser product because the sizes of the pores are reduced. This increases strength and reduces permeability. Globally, the concrete industry consumes large quantities of natural resources, which are becoming insufficient to meet the increasing demands. At the same time, large number of old buildings and other structures have reached the end of their service life and are being demolished, resulting in generation of demolished concrete. Some of this concrete waste is used as backfill material, and much being sent to landfills. Recycling concrete by using it as replacement to new aggregate in concrete could reduce concrete waste and conserve natural sources of aggregate. In the last two decades, varieties of recycling methods for construction and demolition wastes have been explored and are in well-developed stage. Pulverized fuel ash is known to be a good pozzolanic material and has been used to increase the ultimate compressive strength and workability.

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Description	Cement (kg)	Aggregate 20 mm(kg)	Aggregate 10mm(kg)	Sand (kg)	Aggregate cement ratio(%)	W/c
MALWA	160	502	502	867	11.07	0.6

Table 1-Concrete mix design for casting blocks in recycled aggregate

Description	Av. Strength (MPa)	Density of Brick (g/cc)
MALWA Concrete Bricks	15.27	2.218

Table 2-Compartive strength of MALWA concrete blocks and conventional blocks

Description of Aggrega	Cement (Kg)	Aggregate 20mm (K	Aggregate 10mm (!	River Sand (Kg)	W / C
Conventional	300	645	545	841	0.5
Local	300	600	500	821	0.5
Recycled	300	558	498	802	0.5

Table 3 - Design of general Concrete mix in different Aggregates (M 25)

Material	Average compressive strength (Mpa) at				Avg Weight Of cube	Density Of concret	Impermeability Coeff. (10
	7 day	28 day	60 day	90 day			
Conventional	30.08	41.88	46.09	49.82	8.467	2.509	5.09
Local	26.75	30.85	36.47	39.09	7.776	2.304	3.28
recycled	24.59	32.12	37.76	39.56	7.61	2.255	1.71

Table 4-Compressive strength of concrete mix in different materials

2. MATERIALS AND METHODS

2.1 Materials

Many types of aggregates have been used with success for making concrete blocks. These include crushed stone, gravel, sand coral, volcanic cinders, slag, foamed slag, furnace clinker etc. In humid areas, cement must be carefully stored so as to prevent its deterioration through premature hydration. Water free from impurities such as oils, acids, organic matter must be used. Where sulphate- bearing water is liable to attack underground concrete work, it is probably advisable to use stone or brick for foundations together with a sulphate resisting Portland cement mortar.

2.2 Mixes

The mix will vary according to the type of aggregate used; but it should not be richer than one part (by volume) of cement to six parts of mixed fine and coarse aggregates. For making blocks in which no coarse aggregate is used, a mix consisting of one part of cement to six or seven parts of well graded sand is satisfactory; some users employ mixes up to one cement to eight or nine sand depending on the end use of the blocks. For dense blocks aggregates should be well graded to ensure that the small particles occupy the spaces between thelarger ones and leave a minimum of voids. Well-graded sand will produce a much denser block of greater strength and lower moisture movement (although of higher thermal conductivity), than a block made from poorly graded aggregate and sand. When a block of high strength is required, as much large aggregate as possible, using a proper range of gradation, should be included in the mix.

2.3 Mixing

As much water should be added to the mix as will produce water sheen on the surface of the block, and still not cause the block to slump. The length of time in mixing is important. A mechanical mixer is worthwhile.

2.4 Operating the Machine

A few trial blocks will have to be made to arrive at (a) the correct consistency or wetness of the mix, (b) the total volume of ready-mix to be charged into the mould box for tamping. Once this volume is determined it should be fixed. The worker will then onwards dump the same fixed volume each time, in the machine- loading tray.

2.5 Tamping

3" to 6" deep blocks-automatically tamped. The tamper plate (which enters the mould box) is adjustable. For instance, when making 3" slabs it enters to a depth of 1" compressing 4" of concrete into 3" and when making 4-1/2 slabs, to a depth of 1-1/2, compressing 6" of concrete in 4-1/2" thus ensures a uniform compression irrespective of the height of slab. No Hand-tamping whatsoever is needed, as the tamper plate adjusted to the proper compression actually enters the mould box. This makes the operation an exceedingly quick one (i.e. fill the box right up to the top, level off, tamp and eject-the work of few seconds only). Blocks greater than 6" height are partly hand and plate tamped. Plain Blocks upto 6" height. Fill mould to the top and strike off the surplus above the top horizontal plane of the mould. No hand or other tamping being done to this stage. Bring down the lid a few sharp blows on top of the mould and the block is tamped to its required density. The tamper lid should level up with the top of mould at around the last few tamping blows. The block is ejected and picked off on the wooden pallet and taken for curing. The operation is repeated. Plain or Hollow Blocks greater than 6" height These blocks, because of their increased height, are party hand tamped with wooden rammer and finished off with the machine tamper lid. Fill the mould to half its depth and ram the mix well around especially at the four corners of the mould box and in between the two cores forming the hollows. Avoid air pockets or spaces. Hint; Use a suitable wooden rammer say 4-1/2" X 1-1/2" timber about 15" long, tapered and shaped for about half its length for convenience of grip. The square end shod with a piece of flat sheet iron fastened to the broad faces of the wood. Now fill the mould completely level with the top. Bring the tamper lid down swiftly and tamp down the mix in the mould until the tamper lid levels up. The most force is required to overcome initial friction and commence upward movement. Pull up the ejection handle with a littler jerk and then onwards there is no further exertion. The block is picked off on the plain or hollow wooden pallet and taken for curing.

2.5 General

The complete operation being the work of a few seconds only for a practiced operator, provided he is kept supplied with mix, can be expected to produce approx. 90 solid blocks of size 18" x9" x4-1/2" per hour. As the mould box is only filled up once, the same amount of concrete is used for each slab of any one thickness – a great help when working up estimates.

2.6 Curing

Shelter the blocks from sun and draying winds. After 24 hours they should be watered and kept damp. Once moulded blocks have sufficiently hardened to permit removal of the supporting wooden pallet they may be carefully turned on side or edge and the pallet removed, the pallet oiled and reused. Keep blocks damp for several days to permit the cement to hydrate completely. The longer the curing time the better is the strength. The blocks should thereafter be completely dried prior to placing in the wall.

2.7 Mortar for Laying Cement Blocks

When building in concrete blocks a weak mortar is preferable to one rich in cement. Rich or strong mortars are usually inadvisable as they make the wall to rigid, localizing the effects of minor movement. If these movements are not taken up and distributed in the joints they may eventually lead to cracking of the blocks, thus creating a path for termites and entrance for driving rain. A 1 part cement 1 part lime, and six parts sand by volume mortar should be adequate.

2.8 Work Cycle

(i) In the absence of a concrete mixer-for hand mixing and filling of scoops and keeping them ready for transfer of mix to machine hopper tray.

(ii) Dumping ready-for-use mix into hopper tray-taking back emptied scoop and returning to machine with a filled one.

(iii) Feeding mix from hopper tray to mould box, filling mould complete (i.e. level to top of mould) and tamping with the mould tamper lid.

Note :

1. For blocks greater than 6" height, the mix is partly hand-tamped with the mould-half filled and then finished off with the tamper lid.
2. During tamping the lid-plate progressively enters the mould box on each successive tamping blow, Normally the tamper lid should level up with the top of mould box on the fourth or fifth tamping blow.

(iv) Ejecting the block, returning slide to loading position (only after the moulded block has been removed from the machine), cleaning the mould box walls and slide top when necessary and placing a fresh wooden pallet each time into the mould box from a pallet-stack kept nearby the machine.

(v) Picking off the ejected block on the supporting wooden pallet as ejected from the mould and carrying it away to the curing place.

(vi) The use of a concrete mixer will be a great facility when operating a number of machines simultaneously, depending on daily output desired. Some labour will be required for removing the pallets from the underside of blocks previously moulded and now sufficiently hardened to permit separation of pallet, cleaning the pallets, giving them cleaned pallets a wipe with an oily rag and stacking them near the block making machine. Thus to keep the block making operation going, there must always be sufficient number of ready-for-use pallets on hand stacked near the machine.

2.9 Making Plain Blocks

Remove the hollow forming twin cores by unfastening them from the bed of the machine, from below. Use plain pallets – insert the two rectangular plugs into the two windows of the tamper lid and bolt them to the tamper lid. The machine is now set to produce plain blocks.

2.10Pallets

Sample wooden pallets are supplied. Users have to get these made locally in quantity, depending on the daily output desired. It is imperative to have a stack of ready for use pallets always on hand near the machine to keep the blockmaking in continuous operation.

2.11 Output

Solid blocks upto 6" height approx 600 blocks per day.

1 Solid blocks greater than 6" height approx. 500 blocks per day.

2 Hollow blocks upto 6" height approx. 500 blocks per day.

3 Hollow blocks greater than 6" height approx. 400 blocks per day.

4 Blocks greater than 6" height are partly hand tamped with the mould half filled and finished with the tamper lid.

2.12 Maintenance

The machine should be kept lubricated at all points where grease cups have been provided (in all there are six cups.) The check nuts provided on the spring turnbuckles should be kept tight. The bearings of the pin under the slide should be kept lubricated by oiling. The said pin connects the slide to the link. The pin connecting the link to the bifurcated short link at bottom should also be kept lubricated.

3.TYPES OF CONCRETE BLOCKS

S.No	Type of Blocks	Size in MM	Purpose
1.	Solid Blocks	100X200X400 200X200X400	Foundation
2.	Closed Cavity Blocks	75X200X400 100X200X400 150X200X400 200X200X200	Load bearing External works Partition walls
3.	Corner Column Blocks	200X200X400	Corners
4.	Roofing Blocks	410X250X140 530X250X140	Roofs
5.	Bend (U) Blocks	100X200X200 200X200X200	R.C.C. Bend

Table5 Different Size Concrete Blocks

3.1 Materials for Concrete Blocks

Since the ingredients of concrete can be of very different types and qualities, not only depending on their local availability, but also on the desired properties of block, equipment and production method, it is not possible to give detailed recommendations on materials and mix proportions, other than very general guidelines. It is up to the manufacturer to select the most suitable materials and design of mixes by trial and error, and making tests with the available equipment under the conditions of full-scale production.

3.1 Cement

The following cements are commonly used in concrete blockmaking:

Ordinary Portland cement (OPC). most common type used.

Rapid hardening Portland cement (RHPC): more finely ground cement, which hardens much faster than OPC. It is especially useful:

- Where storage space is limited,
- when rapid production is important, and
- to produce good strength blocks despite poor gradation of aggregate.

Block mix cement: marketed especially for block making, but can vary from one manufacturer to another. It has the high early strength qualities of RHPC, but is lower in price.

Special cements: such as Portland blast furnace cement, sulphate-resisting Portland cement and others, used where special properties are of importance. The partial replacement of cement by a pozzolana, eg rice husk ash, pulverised fuel ash, may be acceptable in certain cases, but should not be implemented without prior laboratory testing.

3.2 Aggregates

In order to facilitate transportation, handling and laying concrete blocks, it is necessary to reduce their density. This is achieved by reducing compaction, ensuring a relatively high proportion of air gaps between the aggregate particles and/or using lightweight aggregates. Hence it is important to have a relatively high proportion of coarser particles, because too much fine aggregate would fill the gaps and increase the density. However, a carefully measured amount of very fine particles is necessary to produce the cement paste required to bind the coarser particles.

The maximum particle size of coarser aggregates is 13 mm (or 10 mm for hollow blocks). Rounded stones produce a concrete that flows more easily than angular (broken) particles, but the latter give higher 'green strength' to the newly demoulded block, because the particles interlock. This is very important for concrete block production.

Suitable aggregates are usually obtained from natural sources (eg river beds, gravel pits, stone quarries, volcanic deposits) or from industrial by- processes (eg expanded clay, aircooled, granulated or foamed blast furnace slag, sintered pulverised fuel ash, etc). All aggregates, whether fine or coarse, must be free from silt, clay, dust, organic matter, salts or other chemical impurities, that could interfere with the bond between cement and aggregate or cause deleterious chemical reactions.

3.3 Aggregate-Cement Ratio

After determining the correct blend of aggregates, the proportion of aggregate to cement must be found by trials with different ratios, eg 6:1, 8:1,10:1, up to 16:1 by weight, end testing the qualities of blocks produced.

The proportion of fine aggregate to cement is of special importance: if the ratio is too high, the mortar will lack the cohesiveness needed for green strength and will be too weak to impart enough strength to the matured blocks; if the proportion is too low, the mortar will be very cohesive and the mix may not flow easily in handling and filling the mould.

3.4 Water-Cement Ratio

Only water that is fit for drinking should be used to mix the concrete. The correct amount of water to be added to the mix depends on the types and mix proportions of aggregates and cement, the required strength of the block, and the production method and equipment used. Theconcrete must contain just enough water to facilitate production without any slumping of blocks occuring after demoulding. If the aggregates are dry, they may absorb some of the water (lightweight aggregates may absorb up to 20 % by weight), but if the aggregates are wet, the blocks will take longer to dry out.

As a simple test for cohesiveness, no excess water should be visible when a lump of concrete is squeezed in the hand, but if the sample is rubbed quickly on a smooth round metal bar or tube (2 to 4 cm in diameter) a slight film or paste should be brought to the surface.

4.Production Process

4.1 Batching and Mixing

Aggregates can be batched by volume or by weight, but the latter is more accurate. For this reason, cement should only be batched by weight, or preferrably by using only whole bags of 50 kg. In backyard block production, with less stringent quality standards, batching by volume using buckets, tins, wooden boxes or wheelbarrows is quite acceptable, if done with care to ensure uniform proportions of mix.

Since concretes begin to set within 30 to 60 minutes, depending on the type of cement and ambient temperature, only so much concrete must be prepared as can be used up before that happens. In hot climates, the fresh mix must be shaded from the sun to avoid premature setting.

In case of hand mixing, it must be done on a level, smooth, hard surface (eg concrete slab or steel plate). Because of the relatively low cement content of the concrete and the need for a cohesive mix, thorough mixing is essential. Thus the best mixes are obtained with mechanically operated mixers.

4.2 Moulding

Concrete blocks can be moulded by several methods, ranging from manually tamping the concrete in wooden or steel mould boxes to large- scale production with 'egg-laying' mobile machines and fully automatic stationary machines. The quality of blocks generally increases with the degree of mechanization, but medium standards are normally adequate for most construction purposes. In all cases, the blocks are demoulded immediately after compaction, so that they have to maintain their shape even before the concrete hardens.

4.3 Curing

The blocks are either left to set and harden where they were molded, or carried away on pallets to the curing place. In all cases it is important to keep the concrete moist, for example, by regularly spraying with water, until the concrete has obtained sufficient strength. This can take 7 days or more, depending on the type and quality of cement.

5.Building with Concrete Blocks

5.1Design

In order to minimize the need for cutting concrete blocks, all horizontal dimensions of walls should be multiples of nominal half blocks (most commonly 20 cm) and all vertical dimensions should be multiples of nominal full-heights (20 cm). This also applies to the positioning of doors and windows.

In order to minimize the risk of cracking, the lengths of individual wall sections should not be greater than one-and-a-half times the height.

Hollow blocks should be specified when good thermal insulationis required. These blocks are also useful when additional structural stability is needed, e.g. in earthquake areas, because the cavities align vertically and can be filled with reinforcing steel and concrete.

Blocks with a rough surface (open textured), as in the case of most lightweight blocks, are advantageous, because they

- provide a better key for bedding mortar and applied finishes,
- have less capillary attraction for water and dry out more quickly after rains.

5.2 Construction

Concrete blocks must be dried out thoroughly before use, otherwise drying will continue after building the wall and shrinkage cracks may develop. Only dry blocks should be used and they should not be wetted before lying. Instead the preparation of the mortar must take into consideration that the blocks absorb some of the water.

Mortars used for bedding should not be too rich in cement. Cement: hydrated lime: sand mixes of 1: 2: 9 or 1: 1: 6 have a high water retention and good workability. It is important that the strength of the mortar does not exceed that of the blocks, so that the joints can absorb a limited amount of movement, preventing the blocks from cracking.

6.Results And Discussions

6.1Compressive Strength Test

The test was conducted based on the procedure described in Indian Codal provisions IS 3495(part 1): 1992

6.1.1 Test Results

AAC Blocks

Brick no	Size (cm) L x B	Weight (Kg)	Compression Load (KN)
1	15 x 15	1.995	83.2
2	15 x 15	2.047	83
3	15 x 15	1.986	61.2
4	15 x 15	2.035	68.8

Table6 Compression strength

The Compression strength of AAC blocks = 3.291 N/mm2

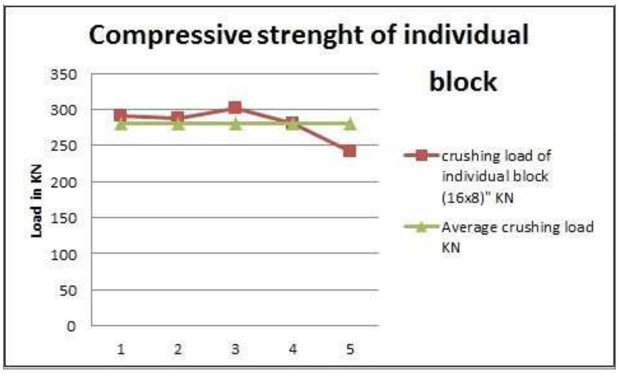
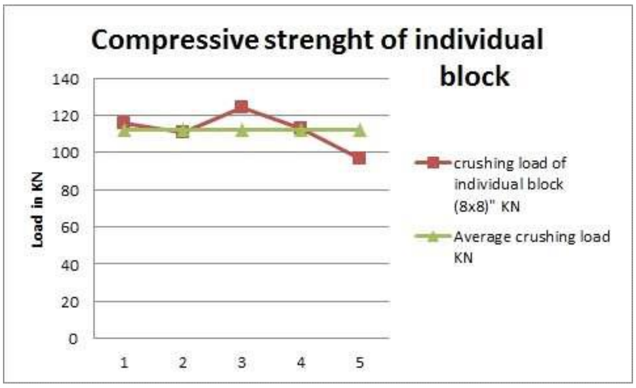
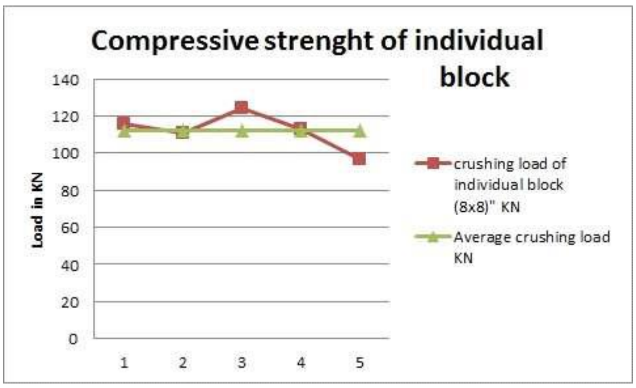


Fig.1 Crack in concrete block wall.



Graph.1 Compressive strength of individual block.



Graph.2 Compressive strength of individual block.

Sample No.	Compressive or Crushing Strength (Kg/cm^2)
1.	159.55
2.	168.88
3.	153.33

Table6 Compressive strength of mortar specimens

7.CONCLUSIONS

Based on the present investigations on Recycled Aggregates, the following conclusions can be drawn. Some advantages of using Recycled aggregate in Concrete Construction are also given.

1. Disposal of Demolition Waste / GARBAGE becomes easier.
2. We can make concrete blocks, like burnt clay bricks out of this type of concrete. By making bricks, the manufacture of conventional clay bricks can be reduced & hence top Soil, which is suitable for Agriculture, can be conserved. This will automatically preserve green environment and save energy.
3. Recycled aggregate can be used in reinforced concrete or Plain Concrete in foundation, Retaining walls, Panel walls etc.
4. Highways are the biggest user of aggregates where it can be used for dry lean concrete (DLC), Shoulder, and paving blocks and inside drains etc.
5. Finer material after crushing of demolition waste and sieving through 4.75 mm IS sieve; can go back to river beds in the same trucks which bring sand from river.
6. It will save the natural resources like Hillocks, River Pebbles etc from extinction.
7. Stone queries or Hillocks will not be affected and hence environment can be preserved. Resulting floods and droughts will be minimized & thus less Deforestation of hilly areas.
8. It can keep the roads and streets clean by not dumping Demolition Waste on the road side as in India. This will also minimize Road accidents because of fewer obstructions.
9. It can generate work for unemployed people like collecting MALWA by Rag pickers and deposit it at Ready Mixed Concrete Plants (shown in Fig 12) who will get some Aggregate.
10. For enforcing the use of Recycled Aggregate in Construction, studies on long term properties

Of the Recycled Aggregate should be done for their properties.

11. Based on such studies, Formulation of Specifications and Codal provisions are done.

REFERENCES

[1] Cho, Y. H., and Yeo, S. H. (2004). "Application of and concrete. Recycled waste aggregate to lean concretesub base in highway pavement." Can. J. Civ. Eng., 31(6), 1101– 1108. Portland cement.

[2] Whir, R. K., Limbachiya, M. C., and Leelawat, T. (1999).

[3] Dhir, R. K., Munday, J. G. L., and Ong, L. T. (1986). "Investigations of the engineering properties of OPC/pulverized-fuel ash concrete: De-formation properties." Struct. Eng., 64B (2), 36– 42.

[4] Otsuki, N., Miyazat, S., and Yodsudjai,W. (2003). "Influence of recycled aggregate on interfacial transition zone, strength, chloride penetration, and carbonation of concrete." J. Mater. Civ. Eng., 15(5), 443– 451. [5] Ravindrajah R S, Loo Y H and Tam C T. (2005) Strength evaluation of recycled aggregate concrete by in-situ tests.Mat Stru; 21(4):289– 95.

[6] Olorunsogo, F. T., and Padayachee, N. (2002)."Performance of recycled aggregate concrete monitored by durability indexes." Cem. Concr. Res.,32(2), 179– 185.

[7] Abou-Zeid, M. N., Shenouda, M. N., McCabe, S., and El- Tawil F. A. (2005). "Reincarnation of concrete." Conc. Int.,27 (2), 53– 59.

[8] Salem, R. M., Burdette, E. G., and Jack- son, N. M. (2003). "Resistance to freezing and thawing of recycled aggregate con- crete." ACI Mater. J., 100 (3), 216– 221.

[9] Tavakoli, M., and Soroushian, P. (1996). "Drying shrinkage behavior of recycled aggregate concrete." Conc. Int., 18 (11), 58– 61.

[10]Gomez-Soberon, J. M. V. (2003). "Relation- ship between gas absorption and the shrinkage and creep of recycled aggregate concrete." Cem Conc Res,25(2), 42– 48.