Slump test with relevant british standards

Describe the slump test in accordance with relevant British Standard and indicate why it is an important test. How would concrete workability be determined if the concrete is required to be very dry?

In accordance with relevant British Standards (BS EN 12350-2: 2009), the slump test is important as it determines the consistency of fresh concrete. The fresh concrete is compacted into a mould in the shape of a cone. When the cone is withdrawn upwards, the distance the concrete has slumped provides a measure of the consistency of the concrete. This is the basic principle of the slump test. The sample of the concrete is obtained in accordance with BS EN 12350-1(British Standards Institute, 2009a).

When undertaking the task of the slump test, the mould and base plate are dampened and the mould is placed on the horizontal base plate. During filling of the mould, it is held firmly against the base plate by clamping in place or by standing on the two foot pieces. The mould is filled in three layers, each approximately one-third of the height of the mould when compacted.

Each layer is compacted with twenty five strokes of the tamping rod. The strokes are uniformly distributed over the cross section of each layer. For the bottom layer the rod is slightly inclined and positioned approximately half the strokes towards the centre. The first layer is compacted throughout its depth, taking care in not striking the base. The second layer and the top layer are compacted throughout its depth, so that the strokes just penetrate into the immediately underlying layer. In filling and compacting the top layer, the concrete is heaped above the mould before tamping is started. If the tamping operation of the top layer results in subsidence of the concrete below the top edge of the mould, then more concrete is added to keep an excess above the top of the mould. After the top layer has been compacted, the surface of the concrete is struck off by means of a sawing and rolling motion of the compacting rod (British Standards Institute, 2009b).

Subsequently, the spilled concrete is removed from the base plate. The mould is removed from the concrete by raising it carefully in an upwards direction.

Immediately after removal of the mould, the slump is measured and recorded by determining the difference between the height of the mould and that of the highest point of the slumped test specimen as shown in figure 1.

The consistency of a concrete mix changes with time. This is due to hydration of the cement and loss of moisture. Thus, tests on different samples should be carried out at a constant time interval after mixing, if comparable results are to be obtained (Wikipedia, 2010a).

The test is only valid if it yields a true slump. This is the slump in which the concrete remains substantially intact and symmetrical as shown in Figure 2(a).

If the specimen shears, as shown in Figure 2(b), another sample is taken and the procedure repeated.

If two consecutive tests show a portion of the concrete shearing off from the mass of the test specimen, then the concrete lacks the necessary plasticity and cohesiveness for the slump test to be suitable. This is why the slump test is important and appropriate for concrete mixes of medium and high workability concrete. There are other tests to establish workability of concrete.

If the concrete is required to be very dry, then this will depend on the water/cement ratio (w/c) of the mixture which has a control over the final properties of the concrete. Selection of a w/c ratio gives the engineer control over two desirable properties. These are strength and workability. A mixture with a high w/c will be more workable than a mixture with a low w/c i. e. it will flow easier. The less workable the mixture, the stronger the concrete will be. The water/cement ratio needs to be about 0. 25 to complete the hydration reaction. Typical values of w/c are between 0. 35 and 0. 40 because they give a good amount of workability without sacrificing a lot of strength (Concrete, 2010).

The vebe test is appropriate for concrete mixes of low and very low workability. This method is a mechanised variation of the slump test and determines the workability of concrete. The concrete is subjected to vibration after removal of the slump cone. It is then mounted upon a vibrating table operating at a fixed amplitude and frequency. The time to complete the required vibration gives an indication of the concrete workability. The vebe test is done in accordance to BS EN 12350-3: 2009 (British Standards Institute, 2009e).

Workability of fresh concrete and the fluidity of the concrete at different water/cement ratio will affect the casting and finishing of the concrete specimen. Strength of the concrete will also be affected. Concrete workability can be determined by many methods. This includes confined flow test methods e. g. compacting factor test, free flow test methods. These methods include slump test and vibration test methods e. g. the vebe test as previously mentioned (ELE International, 2010).

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In concrete mixing, describe briefly the mixing procedure. Why concrete is being mixed in dry state for 60s first, then after water is added and further mixed for 90s?

Concrete is formed by mixing cement, coarse aggregate, fine aggregate and water. This is with or without the incorporation of admixtures and additions, which develops its properties by hydration of the cement. Mixing the water with the cement glues the aggregate together, fills voids within it, and allows it to run more easily.

The object of mixing concrete is to coat the surface of all aggregate particles with cement paste and to blend all the ingredients of concrete into a uniform mass. This uniformity must not be disturbed when discharging from the mixer (Neville, A. M, 1981a, p226).

With concrete, there is an inclination on site to mix it as quickly as possible. It is therefore important to know what the minimum mixing time necessary to produce a concrete uniform in composition and of satisfactory strength. The time varies with the type of mixer and number of revolutions which is the criteria for adequate mixing and not essentially the mixing time.

The are three main options for mixing concrete. These options are mixing by hand, which is probably only suitable where less than about ¼m^3 of concrete is required; using a cement mixer, which is generally suitable where between about ¼m^3 and 2m^3 of concrete is required; and finally buying in ready mix for jobs requiring more than about 2m^3 of concrete which is best and cost effective to buy in a lorry load of ready mixed concrete. The above quantities are only rough guidelines (Practical DIY, 2010).

With mixing concrete, the mixing procedure includes the loading method, the discharge method, the mixing time, and the mixing energy. The loading method includes the order of loading the constituents into the mixer and also the duration of the loading period. The duration of this period depends on how long the constituents are mixed dry before the addition of water and how fast the constituents are loaded. The loading period is extended from the time when the first constituent is introduced in the mixer to when all the constituents are in the mixer. Dry mixing is the mixing that occurs during loading but before water is introduced. Wet mixing is the mixing after or while water is being introduced, but still during loading. This means that materials are introduced any time during the loading period: all before the water, all after the water, partially before and partially after. The loading period is important because some of the concrete properties will depend on the order in which the constituents are introduced in the mixer. The discharge from the mixer should be arranged so that it increases productivity and it does not modify the homogeneity of the concrete (Concrete-Catalog, 2010).

Figure 3 shows the relationship between the range of strengths of the specimen made from the given mix after a specific mixing time. Figure 3 is based on Shalon's tests. It shows how compressive strength is affected by the mixing time. It also shows the minimum, mean and maximum values (Neville, A. M, 1981b)

Figure 4 shows the same tests but plotted as a coefficient of variation against mixing time. From the graph it shows that mixing for less than sixty seconds and ninety seconds produces a noticeably more variable concrete. Prolonging the mixing time beyond the values results in no significant improvement in uniformity. (Neville, A. M, 1981c)

This would suggest why the mixing process is no less than sixty seconds and ninety seconds for each process e. g. when mixing the dry state for sixty seconds then adding water and mixing for a further ninety seconds.

Figure 5 shows the results of Abrams' tests. It shows how the average strength of concrete also increases with an increase in mixing time. The rate of increase falls quickly beyond one minute and is not significant beyond two minutes with sometimes a slight decrease in strength been observed (Neville, A. M, 1981d).

This would suggest why concrete is mixed in dry state for sixty seconds first as the strength falls quickly beyond this and why after water is added it is mixed for a further ninety seconds. This is because the strength increase would not be significant beyond this time with a slight decrease in strength observed as stated earlier.

The influence of mixing time from thirty seconds to one minute permits a saving in the cement content of as much as thirty kilograms per cubic metre.

This was calculated by Shalon which shows how within the first minute the influence of mixing time on strength is of significant importance.

This would assist the fact why the concrete is mixed for sixty seconds first. Thus saving cement content which would have an effect on strength as well as cost.

With the concrete being mixed in a dry state for 60 seconds, then water added and further mixed for 90 seconds, there are no universal rules in the order to add the water and concrete. This can depend on the properties of the mix and the mixer. The mixing time is from the time all the solid materials have been put in the mixer.

When a dry mix is used however, it is necessary to feed some water and the coarse aggregate as otherwise the surface does not become adequately wetted. If the coarse aggregate is not present to begin with then sand or the cement could become stuck in the mixer. If the cement or water is fed too fast then balls may form. Normally, a small amount of water should be fed first followed by the materials. These are, if possible fed simultaneously into the mixer. The greater part of the water should be fed during the same time if possible with the remainder fed after the solids (Neville, A. M, 1981e).

With stiff mixes, it is found to be suitable to feed the sand first, part of the coarse aggregate, cement, then the water and lastly the remainder of the coarse aggregate to break up any round masses of mortar (Neville, A. M, 1981f).

(1, 022 Words)

Describe different ways to be applied to cure concrete on site

Curing concrete on site can be done using many methods. These include retaining formwork in-situ, constant fog spraying, ponding, polythene sheet, steam cure, hydrothermal processes and surface applied materials.

Fogging during and after placing and finishing also helps minimize plastic cracking in concretes with very low water-cement ratios. This is especially around a water-cement ratio of 0. 30 or less (Curing Concrete, 2010).

Ponding as a curing method is easily done. A waterproof wall is needed to form around the concrete, using either the form the concrete was poured into, or a wall of sandbags. Once the wall is formed, the concrete is flooded with water. The added moisture from the flood will keep the concrete from drying out before the bonding process is completed (E-How, 2010).

Airtight polythene sheeting is an efficient way of preventing moisture loss. It should be placed on a concrete slab as soon as the concrete is hard enough to prevent surface damage or marking. With sprayed membranes, these are designed to form a superficial seal on the concrete, preventing water evaporating. Although some prevent subsequent adhesion of screeds or applied finishes (BRMCA, 2010a).

Steam curing is a process for hardening concrete that involves exposure to warm steam. Steam curing requires a fraction of the time involved with traditional curing and quickly strengthens the products so they can be used immediately (Wisegeek, 2010).

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Why is curing important?

Curing is important to prevent concrete from drying out too soon. Well cured concrete is stronger, more resistant to chemical attack and traffic wear. It is also more watertight with curing. It withstands freezing and abrasion better with the processes of curing. Most curing is done by using polythene sheeting or a sprayed membrane. Leaving the formwork in place is also possible, except for slabs, where the large surface area will soon dry if left unprotected. Curing should always start before the concrete begins to dry out and continue for a period depending on the strength gain of the concrete. Poor curing will result in poor concrete, lower strength, lower durability, dusty surface and a weaker surface (BRMCA, 2010b).

To obtain good concrete it must be cured in a suitable environment to allow the concrete to achieve its strength. Hydration and hardening is critical for the first three days. Curing is important In order for sufficient heat and humidity to be maintained within the mix during hydration. Curing allows concrete to achieve its strength, minimise cracking, minimise shrinkage and prevent losses of water. Well cured concrete has better surface hardness and therefore is more watertight. Concrete needs to be cured under controlled temperature and humidity in order to obtain good concrete (Wikipedia, 2010b).

As previously discussed, sufficiently cured concrete will exhibit greater durability, wear resistance, and gain strength faster. Cured concrete will also have better resistance to freeze thaw damage. Improperly cured concrete can be subject to plastic shrinkage cracking (loss of moisture from fresh concrete) and drying shrinkage (loss of moisture from concrete that has set) among other undesired side effects (All Concrete, 2010).

Curing is of particular importance on horizontal surfaces; dry, hot or windy conditions; wear resistant floors; and high strength floors. Abrasion resistance is dependent on good curing but also relies on other factors (Newman, J and Choo, B, 2003).

(301 Words)

Discuss the use of recycled concrete aggregate in concrete

Recycled concrete aggregate is aggregate resulting from the processing of inorganic material previously used in construction and principally comprising crushed concrete (British Standards Institute, 2006).

The process of recycling of concrete is a fairly straightforward process. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality. The quality of concrete with recycled concrete aggregate (RCA) is dependent on the quality of the recycled material used. If there is reinforced steel and other embedded items, these must be removed, and care must be taken to prevent contamination by other materials that can be difficult, such as asphalt, soil, chlorides, glass, paper, plaster, wood etc. The removal of the contaminants is done through selective demolition, screening, air separation and size reduction which is done in a crusher to aggregate size. After this, the crushed concrete can be used as new concrete for pavements, sidewalks, curbs, gutters, structural grade concrete and also bituminous concrete (Concrete Technology, 2010).

The use of recycled concrete material (RCM) as an aggregate substitute in pavement construction includes its use in granular and stabilized base, engineered fill and Portland cement concrete pavement applications. Other applications include its use as an aggregate in flowable fill, hot mix asphalt concrete and surface treatments.

To be used as an aggregate, RCM must be processed to remove as much foreign debris and reinforcing steel as possible as discussed previously. Reinforcing steel is sometimes removed before loading and hauling to a central processing plant. Most processing plants have a primary and secondary crusher. The primary crusher breaks the reinforcing steel from the concrete and reduces the concrete rubble to a maximum size of 75 mm to 100 mm. As the material is conveyed to the secondary crusher, steel is removed by an electromagnetic separator. Secondary crushing further breaks down the RCM, which is then screened to the desired grade. To avoid inadvertent segregation of particle sizes, coarse and fine RCM aggregates are stockpiled separately (TTHRC, 2010).

Recycled concrete aggregates can be used in many things. With bitumen bound materials, recycled concrete aggregate can be used in a variety of base course and binder course mixtures. In concrete, recycled concrete aggregate is permitted for use in certain grades of concrete. In pipe bedding, a suitably graded recycled concrete aggregate is used. In hydraulically bound mixtures (HBM) recycled concrete aggregate can be suitable for use in HBMs with suitably graded recycled concrete aggregate used as a subbase. In capping, recycled concrete aggregate is suitable for capping applications and embankments. Suitably graded recycled concrete aggregate can also be used as fill (Wrap, 2010).

With regards to RCA properties, research carried out in Australia indicates that in general, recycled concrete can be used as natural aggregate in ready mixed concrete with satisfactory performance for low grade concrete. There are also marginal differences in compressive strength and a 10% reduction in strength characteristics. The issues are due to drying shrinkage which is higher compared with natural aggregates as well as a 10% difference in tensile properties (Guy R. Woolley, 2000).

Waste arising from construction and demolition constitutes one of the largest waste streams within the European Union and many other countries. Construction demolition waste has become a global concern which is why a sustainable solution is needed. This is why recycled concrete aggregate (RCA) should be promoted, although the aggregate for concrete applications must meet the requirements set in relevant specifications for its particular use. Recycling and reuse of demolition waste may not always be economic or practical and in some cases may be impacted by the external issues i. e. regulatory and planning controls. If the construction industry and its need for aggregates are considered, then recycling of concrete would give both economic and environmental benefits as well as making the construction industry more sustainable (M C Limbachiya et al, 2004).

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