

Sea sand in concrete – Sabbia di mare nel calcestruzzo

Have anybody got experience in using sand sea or sea water for normal concrete mixing? Plz share with me your opinion about adv and inconv. Of this kind of sand in concrete
Di Khanh-Son - Dr., Lecturer at HCMC Univ. of Technology- BACH KHOA Vietnam

Riprendiamo un'interessante discussione tecnica su INTERNET sull'uso di sabbia di mare nel calcestruzzo che si sta tenendo su LINKEDIN nel Gruppo dell'American Concrete Institute <http://goo.gl/aVF41V>

Possono ovviamente accedere solo gli iscritti a LinkedIn e al gruppo, ma ci è sembrato utile riportare le opinioni degli oltre 30 intervenuti da tutto il mondo.

La discussione – The Discussion

Neil Milestone

It is the chloride content you will need to worry about as this enhances the corrosion of steel. The sodium content must also be borne in mind if there is a possibility of ASR.

Drew Hayes

The only problem with using sea water I see is that it would need to be filtered and desalinized, which I think would be generally more expensive than the more traditional sources. The problem with sea sand I see is the salt content, which is detrimental to the performance of both rebar and the concrete itself.

Joseph Regan

Hi Mr Khanh-Son, No one uses sea water for steel reinforced concrete, only good for mass concrete without steel. Your best option is never introduce seawater. Sea sand is used in China for concrete. Now that is odd but true. You would waste more water cleaning the aggregate than you would in the concrete mix design. Do really think that happens. Go line and see the problems in China and let me know if you are serious on this matter. Regards Joe

Khanh-Son NGUYEN

Thank you for your commens. We just try use sea sand into non reinforced concrete , i dont know we could neglect the effect of cl- or not. For sulfate resistance we had recourse the presence of GBFS in portland high sulfate resistance cement. Mixing step shows good because round shape of sea sand. Have you share your experience on other physio-mechanical prop and durability, we have not tested yet?

Jayasankar Jay

Please find below link from British Marine Aggregate Producers Association webpage related to usage of marine aggregates in concrete http://www.bmapa.org/documents/marine_concrete.pdf

Joseph Regan

Hi Jay, Do you think that anybody reads those specs let alone comply with them in China. Have a look at the demolition of structures made with sea sand, in concrete. Regards Joe

Jayasankar Jay

It depends on implementation agency. Irrespective of geographical location, if you want to have a structure which is functional during entire service life you may have to adopt stringent norms. In locations where river sand is scarce, treated marine sand is to be seen as a viable option for fine aggregate in concrete construction.

Joseph Regan

Hi Mr Jay, your comments are correct but not applicable in China. Regards Joe

Nikos Marsellos

a) You can use sea sand + sea water in plain concrete (non-reinforced)+add 50 kg of cement b)You can use stainless steel+ sea sand+sea water in reinforced concrete. Stainless steel has a cost x5 times the cost of ordinary steel reinforcement! Its your choice!!

Joseph Regan

Hi Mr Nikos, Your comments are valid.Especially its your choice. If you look at the Ping'an financial Centre Shenzhen, China they have carbon high strength reinforcement steel that has produced corrosion product during construction. The concrete was made from unwashed sea water sand for the concrete.. Currently another fifteen buildings in China are under investigation that have been constructed with unwashed sea salt sand for the concrete.. It is worth while noting that Stain-less made in China does not confirm with British Standards,as best I know. As you stated, its a matter of cost. Which contractor in China will use Stain-less reinforcement when they take the cheap option of making concrete with unwashed sea washed salt water sand. You really have to live and work in China to understand the construction industry. Regards Joe .

Khanh-Son NGUYEN

Thank Joe and Nikos for your fruitful discussion, As i well understand, it is really problem of construction cost. For specific construction area such as isolated island, we could think about sea sand aggregate,

Jayasankar Jay

Cost of sea sand is 30 RMB where as river sand costs 165RMBhttp://www.chinadaily.com.cn/china/2013-03/15/content_16311983.htm

Nikos Marsellos

Greece has more than 150 small islands (Aegean archipelagos), where sweet water is seldom to find even to drink ,and is transported there by a ship: You can't tell them to use it in concrete! They built with stones, maybe non-reinforced concrete,and when use cement add 50 kg/m³ in the mix with sea water ,and finally expect a 20-30 years life if steel is used.... Alternatively ,bear in mind that ACROPOLIS-PARTHENON, is 2500 old,built with just marble , and has seen many reinforced concrete buildings in ruins ,after an earthquake, while this monument does't have a scratch. Only the bombardment from "civilized" Morozini has destroyed its roof. So look back in China,Egypt, India ,old civilizations have a lot to offer!

Ara Jeknavorian, Ph.D.

Where sea sand must be used as part of the concrete aggregate, calcium nitrite admixture can offset potential for corrosion potential.

Jayasankar Jay

If nitrite corrosion inhibitor dosage is less than required value, it could aggravate the situation by favouring ...

Terry Stransky

Sea sand could contribute a variety of chemicals detrimental to concrete-chloride (steel corrosion), sulfate (several varieties of sulfate attack), calcium/sodium (ASR formation). The sand should be THOROUGHLY washed (NOT in seawater, either), and then analyzed chemically to determine concentrations of these anions/cations.

Jason Davis

Would epoxy coated steel be resistant enough, aside from washing the sand & the suggested uppage of cement ratio?

Jayasankar Jay

My comment got broken when it was added so find below full comment. If the nitrite corrosion inhibitor dosage is less than required value, it could aggravate the situation by favouring corrosion process. Another aspect is that it only raises corrosion threshold not impermeability so it would be advisable to add silica fume or GGBS into the mix.

Joseph Regan

Hi Dr Ara, I thought calcium nitrate protected embedded steel reinforcement in salt free sound concrete, from the ingress of chlorides on the external surfaces . How does calcium nitrate encapsulated in (a ticking time bomb) with unwashed sea sand concrete protect the steel reinforcement.. I would really appreciate your expert opinion on this matter. The dosage rate for calcium nitrate is generally in the range 3-4%. What dosage rate is required for unwashed sea sand concrete. Best regards Joe

Bob Viles

Calcium nitrite is a corrosion inhibitor. In reducing conditions nitrate can be reduced to nitrite which possibly explains slight evidence of nitrate activity. The nitrite concentration MUST stoichiometrically exceed the chloride ion concentration to be effective. Where that is not the case, corrosion of steel will initiate and ensuing corrosion rates can be accelerated. Ideally you should thoroughly wash the sand with potable water.

Jayasankar Jay

Some experiences from Taiwan "Buildings made with reinforced concrete containing sea sand can only last 6-10 years before they must be abandoned"(Ref: Community awareness webpage <http://w2.flps.tp.edu.tw/interweb/A1.htm> Some unlivable buildings, such as those that had been damaged in disasters, those built with a high level of chlorine (the so-called "houses of sea sand"), and those built with radiated steels, are listed as the top targets for demolition in the Plan of Urban Renewal by the Taipei City Government
(Ref: <http://english.taipei.gov.tw/ct.asp?xitem=1102294&CtNode=8516&mp=100002#> ! & <http://www.taipeitimes.com/News/local/archives/2001/10/17/0000107483>

Ara Jeknavorian, Ph.D.

Just a few follow ups to the many good comments .Let me stress that my advice on the use of calcium nitrite to enable use of sea sand assumes that the concrete producers has no other alternate source of fine aggregate. Using a 2:1 nitrite:chloride ratio(weight basis) for the concrete mixture will prevent any corrosion of embedded rebar assuming no further ingress of chloride into the concrete. Let's also set the record straight on some earlier not-so-accurate statements. Nitrite provides corrosion protection by converting any vulnerable Fe²⁺ on the rebar surface to the stable, unreactive Fe³⁺. Chloride ion attacks the Fe²⁺ sites to facilitate the production of expansive rust forming compounds.. The nitrite is converted to nitric oxide, NO. Finally, it is calcium nitrite, not calcium nitrate, that has clearly been demonstrated to be a corrosion inhibitor.

Joseph Regan

Hi Dr Ara, China and Taiwan have plenty of alternative sources of fine aggregate. The use of unwashed sea sand in concrete just boils down to saving dollars, initially . I have never been to this place where the RMC suppliers have no alternative source of aggregate. Clear logic dictates where RMC batch plants are set up. Having worked in South Africa in the Karroo, being hundreds of miles from the next town we did not have any problems building concrete bridges and underpass's. The Atlantic ocean was close by! In parts of

the railway route. Thus I consider your reply has no credibility or validity. Everyone is entitled to an opinion. Regards Joe

Boudewijn (Baudouin) Piscaer

Sea sand and gravel is used a lot in the Netherlands, but washing in our country is not a real problem having too much rain. However, we should learn to construct again without steel as Nikos said. Concrete block production in southern Europe uses chloride containing accelerators, so no problem as long as there is no steel. Plus, concrete can be used again for CO2 uptake.

Ala Al-Kazzaz

There is another negative aspect of using sea sand which has not been tackled by our colleagues, it is the gap gradation, especially on the finer sieves, that can not be adjusted by coarse aggregates. Moreover round particles tend to lower concrete strength, while desert sand of sharp edges due to wind erosion contributes about 25% gain to the strength. Back in the eighties, I managed a sea port project when we used sea water for concrete curing and through dredging & hydraulic filling, we replaced vast quantities of spoiled soil inland. Sea sand forms uniform beaches and when saturated they are utilized as car-racing tracks.

Ara Jeknavorian, Ph.D.

Joe, I am very happy to hear that for your projects, there has never been the need to use sea sand. However, the question that originated this discussion concerned what influence can sea sand have on concrete properties, IF one uses it. My comments were strictly concerning the use of calcium nitrite to offset corrosion potential.

Boudewijn (Baudouin) Piscaer

Ala, you are completely right on the grading and round shape, though I will find out how come they use sea water aggregates on a big scale in the Netherlands. However, it is the art of sustainable structures to make due with what you have on the spot. Example; they build a bridge in Northern Norway and in order to fulfill the demands of the engineers, they transported aggregate for about 1200 km. If they would have adjusted the design, they could have used local materials next to the site. The other aspect is, if you do not use steel, permeability is less a problem and if you adjust for strength in the design by increasing cross sections, low strength concrete has a great future as well. Further, thermal mass can become very beneficial. So the interaction with engineering community with producers, contractors, owners and regulators has to be intensified.

Dr. Rajamane Nirmalakumar Parshwanath

If sea sand is cleaned/washed to reduce its chloride level acceptable level, it can be used in steel reinforced cement concretes. Use of sea sand in plain concrete can be made depending upon the environmental conditions of the usage of such concretes.

Sanjay Gupta

Generally not acceptable. On remote islands where fresh water and river washed sand is scarce, they have to resort to this option, many areas in Sri Lanka have tried this method.

Paul Van Benschoten, SE LEED AP

I recently investigated a four-story concrete moment frame structure with URM infill that had a large column spall. The concrete matrix contains a large quantity of sea shells. Laboratory testing of 12 random core samples throughout the structure indicates concrete strength ranging from 1000 psi (6.9MPa) to 2000 psi (13.7MPa). There is severe corrosion of the reinforcement causing approximately a 20% reduction in the net section. An ASCE31/ASCE41 evaluation indicated that the building did not meet the Collapse Prevention seismic performance objective. The building was constructed in the mid 1980s in a region of very high seismic risk. The owner, concerned about the safety of his staff, abandoned the building.

Jayasankar Jay

As per Eurocode, design service life of a typical building is 50 years. When constructing a building for such a life span we need to consider the effect of surrounding atmosphere on the reinforced concrete building, construction quality, concrete mix design...etc. Exact chloride concentration determination will be difficult since in a saline environment existing in coastal areas, there is always a chance of diffusion of chloride ions into the concrete. This process will continue for the entire life span of the building. So dosage of corrosion inhibitor added always comes on the lower side when service life of the structure is considered. In the research article authored by Dr. Do-Gyeum Kim (KICT – South Korea) and his colleagues titled “The Effects of Chloride on Durability of Concrete Mixed with Sea Sand” the author had drawn a conclusion after carrying out extensive tests spanning over 30 years (1984 to 2014). Following conclusions were drawn from the extensive tests: - Chloride content caused by its sea sand contents accelerated carbonation. - Compressive strength of the test pieces is generally inversely proportional to the salt content. Compressive strength declined as the concrete ages. Trend becomes more significant with chloride content. So the author had recommended further examination of sea sand effect on compressive strength over a longer period of time. - Reinforcing bar corrosion area also increased in the test pieces with chloride contents of 0.2% or above.

Matt Cargill

The salinity is too high for long-term structures. There could be a washing technique that might make it useful.

Aggiornato al 7 novembre 2013