Discussion Forum

Infrastructure regeneration: The challenge of climate change and sustainability – Design for strength or durability?

This has reference to the paper titled, 'Infrastructure regeneration: The challenge of climate change and sustainability – Design for strength or durability?', by Prof. R.N. Swamy published in the July 2007 issue of the, 'The Indian Concrete Journal'.

It is good to know that Professor Narayan Swamy has appreciated the importance of emphasising durability rather than attaching all the emphasis on strength in the case of concrete, concrete structures and their constituent materials.

It is good to know that Professor Narayan Swamy has now recognised the folly of the last two/three decades during which period higher and higher early strength OPC was emphasised over OPC of earlier periods, when such OPC had much lower C_3S/C_2S ratios and when the characteristic surface of cement was lower.

It is good to know that Professor Narayan Swamy has now recognised the superiority of concrete of earlier decades when not as much of blended cement was in use as it is the case today.

It is good to know that Professor Narayan Swamy has recognised the better performance of concrete structures of earlier decades when it was customary to cure concrete for 28 days.

It is heartening to note that Professor Narayan Swamy has started liking concrete structures of yesteryears when it used to be conventional to use plain round bars of mild steel and not high strength rebars with surface deformations, with or without surface treatment to such rebars.

In expressing concern at the alarming and unacceptable rate at which the infrastructure systems all over the world are suffering from deterioration, Professor Narayan Swamy has expressed his utmost surprise in the massive and horrendous infrastructure crisis in spite of the tremendous advances (in his view) that have been made in the understanding of the science, engineering and mechanics of materials and structures.

It cannot be denied that surprises can be there only when there is a lack of prior information or knowledge.

In the case of concrete structures, it was pure and simple lack of knowledge.

Will Professor Narayan Swamy disagree with me if it is suggested that much of the paid research on rebars and concrete and its constituent materials during the last three or four decades lacked common sense and honesty of purpose resulting in the 'most surprising' outcome for which society has started paying a very high price ?

In fact, Prof. Narayan Swamy will find in literature that "the alarming and unacceptable rate at which the infrastructure systems all over the world are suffering from deterioration" should not have been 'most

surprising'.[1-9] Instead, this early distress in concrete structures of recent decades was predictable.

References

1. Kar, A.K., Concrete jungle – Calamity may be waiting to happen, *The Statesman*, 4th August 2000.
2. Kar, A.K., Concrete structures – The pH potential of cement and deformed reinforcing bars, *Journal of The Institution of Engineers (India)*, June, 2001, Vol. 82.
3. Kar, A.K., *Deformed reinforcing bars and early distress in concrete structures*, Highway Research Bulletin, Number 65, Highway Research Board, Indian Roads Congress, New Delhi, December, 2001.
4. Kar, A.K., IS 456:2000 on durable concrete structures, *New Building Materials & Construction World*, December 2003, Vol. 9, No. 6.
5. Kar, A.K., FBEC rebars must not be used, *The Indian Concrete Journal*, January 2004, Vol. 78, No. 1, pp. 56-58.
6. Kar, A.K., Concrete in the context of durability, *RITES Journal*, April 2006, Vol. 8, No. 1.
7. Kar, A.K., Deformed rebars in concrete construction, *New Building Materials & Construction World*, December 2006, Vol. 12, No. 6.
8. Kar, A.K., Concrete structures we make today, *New Building Materials & Construction World*, February 2007, Vol. 12, No. 8.
9. Kar, A., The ills of today's cement and concrete structures, *Indian Roads Congress*, 2007, Vol. 68, No. 534, Part 2, 2007.

Dr. A.K. Kar
BC 192 Salt Lake City
Kolkata 700 064
West Bengal

The author replies

I am rather intrigued and perplexed by the nature and form of the comments of Dr. Kar, many of which are simply not related to the focus and thrust of my paper. His comments give the impression as if he has an axe to grind. Nevertheless, I would like to respond to some of the points raised in his discussion which are appropriate to the paper.

His comments about the use of plain round mild steel bars compared to high tensile deformed bars are totally incorrect and misleading. The uniqueness and success of reinforced concrete (RC) as a composite structural material depend not only on the engineering and durability properties of both concrete and steel but also on their ability to preserve and sustain the bond between them, and the resulting composite action throughout their service life. It is this unique bond between steel and concrete that enables RC to withstand a wide range of static and dynamic forces and produce structural elements that are strong, stable and aesthetically pleasing. There is extensive international research published in peer-reviewed journals that show that deformed, high tensile steel bars are far, far superior to plain, round mild steel bars in enhancing the bond characteristics between steel and concrete, and in controlling the cracking and deflection associated with RC structural behaviour. It is very surprising, and simply not acceptable, that in spite of these extensive studies, and excellent field performance of deformed high tensile reinforcing bars compared to plain mild steel bars, such misleading information continues to be propagated.

I must again express my surprise – and indeed my concern – at the rather condescending and patronising tone of the discussion of Dr. Kar. It appears to smack of a certain degree of supercilious attitude. Dr. Kar is entitled to his views but should not impute his views on to others – such statements are unacceptable.

One of the main reasons for the long-term durability of some of the ancient civil engineering constructions standing up even today is because of the use of pozzolanic cements. There are again extensive research studies reported in published literature – by scientists who have devoted a lifetime of their work to the science, microstructure, and engineering of cement-based materials - which prove conclusively the superior durability performance of concretes containing pozzolanic/cementitious cement replacement materials compared to that of concrete containing Portland cement alone. Any views or suggestions contrary to these well established research findings can only be treated as ill-informed and un-informed and should be totally rejected. I again totally disassociate myself from the views of Dr. Kar on funded research on concrete materials and concrete structures.

All construction materials, whether made of steel, concrete, timber, bamboo or whatever other material will deteriorate with ageing when exposed to real life environments. Concrete is an extremely complex material, and the behaviour of concrete structural elements is also equally intricate and complicated. For every case of damage or deterioration experienced in the service life of concrete structures and reported in

literature, there are hundreds of unreported cases where the material is able to give excellent service life. Without exception the deterioration process of concrete materials and concrete structures arises from a lack of clear understanding of the durability characteristics of the material when exposed to unpredictable and aggressive environments - or when misleading information such as those mentioned by Dr. Kar on the type of steel reinforcement and the use of blended cements is used in design. This same situation applies to all construction materials. Concrete should not be blamed for the failings of design engineers and for our lack of understanding of the mechanics and mechanisms of deterioration processes.

Concrete is an international construction material, and is in an unique position to be able to eradicate world poverty and provide a decent quality of life to all peoples of the world. What we need to guard against is misleading information and untenable conclusions, whatever be the source from which they emanate.

R.N. Swamy
Emeritus Professor
University of Sheffield
Mappin Street,
Sheffield S1 3JD
UK