Discussion Forum

National Building Code of India 2005: The building code for the nation

This has reference to the above article published in the July 2006 issue of the journal. I understand that the Indian code on reinforced concrete chimney, that is, IS 4998 (Part 1) : 1975 has been withdrawn recently by the Bureau of Indian Standards (BIS). To give a background of this code, it dealt with design criteria by working stress method, apart from giving permissible stresses for concrete and reinforcement, design formulae for calculation of stresses for various combinations of loads including temperature, etc. As this code was outdated and inadequate in dealing with the latest theory on dynamic aspects of wind load, a separate code for assessment of loads was brought by BIS in 1992. This code was also named as IS : 4998 (Part 1), but of year 1992, which in fact is an additional code to IS 4998 (Part 1) : 1975. For those unfamiliar with the chimney code, it gave an impression that the 1992 code superseded the 1975 code. The Part 2 of IS 4998 intended to contain design aids, charts, graphs, etc, never saw the light of the day till date.

An interesting point is that IS 4998 (Part-1) : 1975 is also used for the design of circular shafts of elevated water tanks, TV towers, bridge piers and the like, by working stress method. Chimneys and TV towers as high as 275-300 m have been built in India using this code for a long period of nearly 30 years and it may be noted that there have been no reports of structural failure yet. But, the odd failures of shafts of elevated water tanks in the country in recent years have drawn considerable attention and apprehension among civil and structural engineers. In many cases, without having done a thorough investigation on these failures which could be due to several reasons, some engineers have jumped to the conclusion that these failures are attributed to the design done by working stress method. Besides, there has been a feeling among many academics and design engineers that this code is outdated as all international codes on chimney, that is, ACI, DIN and CICIND have adopted limit-state or ultimate strength method for design long ago. Technical books on chimneys by G.M. Pinfold and S.N. Manohar also deal on this subject.

Even if we agree to the general opinion that the chimney code should include limit-state method for design, there exists considerable differences between the prevailing international codes mentioned above especially in the method adopted to estimate the ultimate moment capacity of the annular section subjected to normal compressive dead load and wind/ seismic moment. These disparities are primarily due to differences in the concrete stress-strain models and different load factors considered by each code. The ACI code and books by Pinfold and Manohar consider that the stress-strain of concrete in compression at the ultimate state is no different from that of the solid rectangular section for which analysis is well established with supportive experimental findings. However, experimental studies on hollow cylinders are far too limited in

scope to fully substantiate this method of analysis. On this subject, a technical paper titled, 'Ultimate strength of tubular RC tower sections under wind loading' by P. Srinivasa Rao and Devdas Menon, published in the February 1995 issue of ICJ makes a good comparison of the various methods apart from revealing disparities in the predicted ultimate strength values and have also proposed an improved and refined theoretical formulation.

Besides wind and seismic forces, structures like chimneys are subjected to additional temperature load which is of a permanent nature. Regarding the effect of temperature under ultimate conditions, there is conflicting evidence on the strength of concrete at prolonged high temperatures although chimney codes of ACI and CICIND have made an attempt to include it. The strength of the shaft section under temperature load also depends on the permissible crack width under service load condition.

In view of the disparities and uncertainties cited above, the adoption of limit-state method in chimney code is not an easy task. It would be prudent to adopt both working-stress and limit-state methods for the chimney design and consider whichever is critical during application. This also applies to other structures having annular shafts and where chimney code is referred.

The present status of having no Indian code on chimney design for guidance leaves Indian civil engineers high and dry. It must be said that the withdrawal of IS : 4998 (Part 1)-1975 without releasing an alternative replacement would have serious repercussions and raises many unanswered questions. What will be the reference that Indian chimney designers will have to follow now? Is it the easily accessible chimney code ACI 307-98? ACI 307-98 cannot be used in isolation but scores of other American codes viz. ACI 318, ASCE 7, UBC 1994, ASTM C-1298, etc. associated with it would also have to be used in conjunction. What happens then to the use of associated Indian codes like codes for wind and seismic loads used for chimney design? Not all Indian engineers are conversant with the intricacies of alien foreign codes. Indian chimney designers are now thus put into a state of limbo!

It is high time the BIS brings out an alternative chimney code at the earliest although it is wishful thinking considering the past records regarding formulation of Indian codes which take several years. With everyone willing, I hope it can be brought out early with the guidance of academics and practising engineers involved in chimney design.

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