Discussion Forum

Repair and upgradation of RC silos using FRP

I have read with keen interest the paper titled 'Repair and upgradation of RC silos using FRP' by B.V. Bhedasgaonkar, Dhananjay Joshi and M.K. Kamat, that appeared in October 2004, Vol. 78, No. 10, pp. 37-42. While it is interesting to read a case study of a 'relatively new' repair technique employed, I would like to seek further information on the investigation carried out by the authors.

Fig 1 does not show the feeding mechanism for the silo. It is also important when evaluating the possible causes for the distress in structure. Further, *Fig* 2 does depict a vertical crack in the silo as also *Fig* 3 – showing the bulge in the silo shell. As there is no mapping of the cracks in the silo shell, it is not clear if it is an isolated crack or if there were many cracks. Also, such a mapping of cracks would indicate the extent of the crack, that is, from which height and to what height. Such a detailed mapping of cracks for the chimney structure is furnished in reference 1. In the absence of such details, it is rather incorrect to arrive at the causes of cracking. The authors have reported 'due to corrosion, the reduction in the area of steel was upto 35 percent in some areas'. It is not clear how they evaluated this — may be by visual inspection? Normally, repair agencies depict the worst corroded portion only.

The photograph the authors have given in *Fig* 4 does not show such severe corrosion at all. Even assuming that there was 35 percent corrosion of reinforcement, still the reinforcement is adequate as per the details furnished in *Table* 2 by the authors. At a depth of 1.5 m, steel provided is 4.17 cm^2/m. Steel required is 2.353445 cm^2. Even if 35 percent is corroded, still the residual steel available is 2.7105 cm^2 — much more than that required. Similarly at 10.5 m depth steel provided is 18 cm^2 while the steel required is 11.11571 cm^2. Even if 35 percent of the steel is corroded, steel available is 11.7 cm^2 — more than 11.11571 cm^2. Only at a depth of 21 m the corroded steel is 13.65 cm^2 as against 15.1427 cm^2. But the shell does not come into contact with stored material at this depth. Hence, it is essential to know where and what depth the cracks were pronounced. Without such examination one should not come to any definite conclusion regarding the causes of the failure. The cause for the failure may lie perhaps elsewhere. The authors should have examined the feeding mechanisms for the silo and also prepared exhaustive mapping of the cracks to explore the possible causes for the distress.

I would be thankful if the authors could furnish all such information.

These two observations do not diminish the value of the paper in any way. They have been brought to the notice of the authors only as an advice for future rehabilitation projects.

Reference

1. Arthanoor V.A., Srinivasan, D. and William, Casey Repairs to reinforced concrete chimney by the crack injection method, *The Indian Concrete Journal*, April 1975 Vol. 49, No. 4 pp. 98-100.

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The authors' reply:

On behalf of the authors, I am thankful to Mr Srinivasan for his critical review of the paper. Our response is as follows:

(i) The feeding mechanism of the silo is through a conveyor system at the top. The size of motors, loading of conveyor system and the rate of feeding were found to be insignificant to the loading from the stored material. Therefore, the possibility of distress due to feeding mechanism was ruled out.

(ii) The actual photographs show only one crack. There were several cracks on the silo surface. The portion where cracks have occurred sounded hollow. One such location was repaired in 2000 as mentioned in the paper. This location showed corrosion of vertical and hoop reinforcement. The entire cover concrete in the patch of 20 m^2

had come off. This is a clear indication of corrosion induced distress. Similar patches were seen in accessible areas of silo before taking up the repairs.

(iii) Since the purpose of the paper was to highlight the application of a new technique for strengthening and not investigation of the distress, the portion of assessment of distress, extent of corrosion, loss of cross section were not reported, although the same were assessed in detail.

(iv) As a repair philosophy, the system is always designed for the worst location and adopted everywhere. It is not practical to change the repair system from location to location.

(v) The photograph clearly shows the extent of corrosion — there is no patch of cover left! The original reinforcement was known from the drawings. The loss of cross section was substantial. This was evaluated after the corrosion scales from the patch shown in the photograph were removed and reinforcement was cleaned.

(vi) The hopper portion is only 4 m high from ground. The location of 21 m from top represents the lower-most region in the cylindrical portion. No strengthening has been done below this level.

(vii) The reinforcement remaining after loss of section due to corrosion may appear to be adequate in some locations — it is only theoretically possible to say so. First of all, in corrosion affected structure the approach is to provide strengthening over and above that theoretically required because shut down of the functioning of structure are not possible frequently. The costs of erecting scaffolding, providing corrosion protection, repairing the damaged patch etc are substantial. Providing additional hoop capacity adds only marginally to the overall cost. Moreover, the quality of concrete was not very good and there were apprehensions over the effectiveness of the remaining reinforcement on account of development of full bond stress in the distressed concrete environment. As a result, additional hoop strengthening with fiberwrapping was provided.

Hope the above explanation is able to answer to some extent the queries of Mr Srinivasan.

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