CSMT FOOT OVER BRIDGE COLLAPSE AND STRUCTURAL AUDIT – STRUCTURAL ENGINEERS' VIEW POINT

Unfortunate incident happened on 14 March 2019 when part of the deck slab of Himalaya foot bridge outside CSMT collapsed killing 6 people and injuring more than 30 people.

In one day, Chief engineer Vigilance from Municipal Corporation of Greater Mumbai provided the preliminary report. Is CE (Vigilance) competent to prepare such report? Why this CE (Vigilance) did not make this report earlier? Why did he wait till 6 people died?

MCGM suspended some junior officers and started departmental enquiry against some of their officers. Show cause notice was issued to the Structural audit firm Prof. D D Desai's Associated Engineering Consultant and Analysts by MCGM. The question is who is to be blamed for the bridge collapse? It's a system failure. The Electronic media, print media along with MCGM put the blame on structural engineer Niraj Desai who audited the bridge and reported that bridge requires minor repairs. As usual, the structural engineer who had given the audit report had been made a scape goat. Police arrested him like a criminal and put him behind bars. FIR has been filed under stringent Section 304 (II), culpable homicide not amounting to murder which attracts up to 10 years in prison. **Any engineer has no intention to kill when he does his work.** The humiliation and arrest of a professional without any technical inquiry was not warranted.

Structural audit process of all bridges in MCGM limit was initiated in Oct 2016.

There are many unanswered questions. This bridge was repaired during 2012-2014. How? Who repaired? Was any advise taken during repairs? Are MCGM engineers competent to repair? If they are, how they did not find, even when the audit was going on that it is on the verge of collapse? Why should a bridge collapse within 5 years after repairs? Will MCGM put the facts in public domain about, why they thought repairs were necessary? Did any one certified after repairs that Bridge was safe?

There was partial collapse of Gokhale Bridge pedestrian pathway portion at Andheri on 3 July

2018 due to over loading and corrosion. No one was arrested.

On 2 Jan 2004, under construction foot over bridge near Dombivli collapsed and two persons died. The design and supervision was done by Railway Department. It was later found out that there was a design fault. Only person arrested that time was contractor who was not responsible for design.

Probable cause of collapse ?

The bridge was standing for last 30 years with some repairs done five years back by MCGM. In the present case, prima facie it appears from study of the photographs and video clips that the collapse of secondary beams was due to shear failure of welded joints due to corrosion. Detail investigation by experts will throw more light on the exact cause of collapse.

It is surprising that MCGM had immediately dismantled the entire steel bridge there by destroying the evidence for any forensic investigations. Secondly, as per the press report around 10,000 people that were using this bridge daily would be affected. The beauty of steel structures is that it can be modified , strengthened very fast without adding much weight. With the help of expert advise, it would have been possible to re-erect the steel deck on the existing bridge skeleton (which was more or less intact) and open it for public in a weeks time. This opportunity has been lost.

Structural Audit

The word "structural audit" has a very broad meaning which includes the audit of the original design, calculations, structural drawings, quality of construction and workmanship, audit of any major repair, maintenance of the structure done by owner over the years, its present condition from stability point of view etc. Purpose of structural audit needs to be defined. But in present context, the word "structural audit" has been wrongly used by authorities like MCGM to represent only condition survey or inspection report by structural engineer based on the data provided and some tests carried out. Indian Society of Structural Engineers (ISSE) had insisted that it should be called "Condition survey / Inspection report" and not Structural audit.

Process of Structural Audit :

One has to clearly understand the meaning of the phrase "structural audit" as nomenclature by the authorities. The process of carrying out structural audit is a complex one and has many limitations. Most of the times, the person carrying out structural audit of any structure is not the original designer of the structure. Client / owner has to provide all the details like copies of original plans, construction history, test reports during construction, quality control reports, history of any subsequent changes made to the structure or repairs carried out, copies of earlier structural audit and other relevant documents related to the structure. Based on the data provided, structural engineer visits the site , inspects the structure, takes photographs of the important structural components. He may or may not carry out some non-destructive tests as may be felt essential by him. Studying the collected data and based on his experience and judgement, he provides an inspection report to the owner which is termed as "structural audit report ".

Limitations of Structural Audit :

Most of the times, the data about the original structure is not available with the Client / Owner. In such situation, the structural engineer has no clue about the original design and he has to go by his own judgement.

Secondly, it is the responsibility of the owner to provide access to all structural elements for inspection. In case of buildings, many structural compoents like columns and beams are covered by non-removable false ceilings and other interior items and are not accessible. In case of bridges, all the joints, main girders, secondary girders, bearings etc may be or may not be accessible. In such situations, it is really a challenge to inspect the structural components. In steel bridges, it is very difficult to estimate the extent of corrosion in various parts of the bridge if it is not accessible.

MCGM is forcing structural engineers to carry out stipulated non-destructive tests enlisted by it (those are for concrete structures) which should be attached with the audit report. Without the said tests, the audit report is not accepted. Indian Society of Structural Engineers (ISSE) had suggested MCGM that let the structural engineer decide on whether to carry out any non-destructive tests or not and type of tests required for the given structure. But this was not accepted. It is like the medical practitioner recommending type of tests based on his diagnosis.

It is understood from the press reports that non-destructive tests which are meant for concrete were carried out for this steel bridge ? ? ? ?

Structural engineer providing the audit report is acting in a capacity of a consultant and there can be variation in the reports from person to person based on quality of data available and his expertise. A consultant can not be entirely blamed for any such accidents unless proven by a detailed technical inquiry. A time has come that we need to draft a code for audit coupled with responsibilities, exceptions, limitations, methods, specify (minimum) tests for different types of structure and certification formats.

Reasons for collapse in general :

There can be many reasons for the collapse of a structure in general .

1. Deficiency in the original design.
2. Deficiency in quality of Materials and or workmanship used during construction.
3. Changes made by occupants by damaging any critical component there by endangering stability of the whole structure.
4. Overloading of the structure.
5. Neglect of regular maintenance which results in gradual degradation of the strength and stability. When the damage like corrosion reaches to such a level that the capacity falls below the actual loads to be supported, collapse occurs.

It is really difficult to point finger at one person for collapse of the structure as there can be many complex parameters responsible on case to case basis.

Suggestions :

Following are some suggestions for improving the performance of our assets and minimizing the risk of collapse –

1. Clearly define role and responsibilities of external consultants. Follow transparent process of selection of competent external professional not only on lowest cost but on the experience, capability, infrastructure etc as followed for World bank aided projects.
2. Provide adequate time to the professionals to carryout their work and have balanced contract terms and conditions which are enforceable and realistic.
3. Preserve and provide the data of original structure including design basis report, structural drawings, construction history and material test reports, data on subsequent repairs and any addition alteration done. This data is very useful during the structural audit and further retrofitting.
4. Every bridge needs to be Inspected as mandated by Indian Road Congress guidelines (IRC). Such inspection should enable the bridge inspector to create a prognosis for the cause of distress. Such prognosis should be confirmed or rejected by proper testing. IRC has specified over 24 different tests to confirm the cause. Once the cause is confirmed then remedial action for that cause needs to be adopted. Progressive inspection records should be stored in a database like IBMS (which has point based marks) for further analysis and determination of probable balance service life, risk involved in prolonging repairs etc. This data base for all the assets will be helpful in taking correct decisions at the correct time.
5. MCGM has full fledged bridge department with experts and engineers who can manage the assets with proper planning and budgeting for repairs in consultation

with experts in the field. Training of engineers in design and inspection will help.

6. Structural audit formats and procedure can be prepared in consultation with experts in the field and referring to international standards. Rationalisation of certification formats is necessary.
7. Allocate sufficient budget for maintenance of all assets.
8. Government should put all the technical reports on collapse in public domain, so that, we learn from failures and similar mistakes can be avoided in future.
9. Do not waste energy in blame game trying to find the scapegoat. Believe in working together with consultant. Nobody is perfect and has all the knowledge in the world. So, work in a complementary manner with all the agencies involved like Consultants, Engineers from authorities, contractors and whoever is involved in the work to achieve safe structures during repairs or new construction.
10. Make the agreements with all agencies very crisp and clear pertaining to their responsibilities and fees. Pay the fees in time after completing the job.
11. Take up the repair work within time as mentioned in the report and keep the funds ready well in advance, so that, no time is wasted due to lack of funds and approval procedure.

We hope that the overall system will be improved in consultation with experts and professionals and we will be able to minimize the risk of collapse in future.

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