4.1.13. MONITORING OF RISK IN LARGE-SPAN CONSTRUCTION

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Paper is devoted to evaluation of survivability and safety of large-span constructions by means of risk monitoring.

Recently, the series of serious accidents has occurred at various facilities: terminal in the Paris-Charles-de-Gaulle Airport; building of Basman market; covered parking near commercial complex "METRO" by the Dmitrovsk highway in Moscow; Moscow water park "Transvaal". Many factors were called as the reasons of accidents. Though more than 200 expert examinations were carried out, specialists did not come to categorical and comprehensive conclusions yet.

The most cost-efficient method to provide survivability and safety against progressive collapse of constructions during emergency impacts consists in preventive measures that can be elaborated only based on the risk monitoring.

Analysis shows that, within the list of accidental situations, deficiency in design standards amounts to 10%, poor design concept 35%, low quality of construction materials 2%, poor manufacturing and assembling quality 39%, drawbacks of operation 12%, coincidence of unfavorable factors 2%.

In decision-making process, the following must be considered:

– reasons and types of accidental exposures;

– possible consequences of progressive collapse, including threats for human life and health, as well as economic losses;

– cost and complexity of measures on provision of structures safety against progressive collapse.

Impacts of accidental exposures and potential hazard in general can be eliminated or reduced for the account of redundant increase of degree of the system static indeterminateness. Preventive measures are directed toward prevention of unforeseeable disastrous events in order to reduce probability and amount of damage.

Standard approach to prevention of progressive collapse presupposes that construction must not lose carrying capacity in the event of removal of the part of elements during accidental exposures.

Special attention should be paid to the fact that strength and stability of construction in the event of local accidental exposure must be provided at least for the time required for people evacuation.

In 70% of cases, accidents with operation term of construction of less than a year occur in the results of rough mistakes committed during designing and construction.

Results of expert examinations of accidents at the Basman market and water park "Transvaal" are discussed and analyzed.

It is demonstrated that all cases of collapse have two common circumstances. First one – thin-wall concrete structures (plates, shells) were applied in constructions; second one – sources of mechanical oscillations (vibrations) were located near or inside of the buildings.

Under action of vibrations, transverse waves occurred in thin-wall elements of water park resulted in appearance of bending strains. Long-term vibration impact could result in growth of micro-defects in a concrete. Defects in the form of micro-cracks reduce stiff-

ness of structures, which, in its turn, reduces the free oscillation frequency. At this conjuncture, amplitude of covering oscillations appeared to be high and concrete was degenerating quickly. Therefore, not long time has passed from erection to accident.

For minimization of vibration exposure, it is necessary to provide dissipation of the energy of oscillations occurred in construction. Dissipation occurs in the result of internal friction or waves exit into soil.

In "Transvaal" water park, fixture of pillars was close to hinged one. Therefore, deformational waves were not attenuated due to internal friction and did not exit into the basement, while were reflected from hinge and returned again to construction elements. This fact, of course, also was increasing the risk of collapse.

With application of hinged support, oscillations do not overpass the hinge and return into system. With elastic fixing, oscillations occur along the whole length of rod. Rod section in fixing zone has linear and angular degrees of freedom, experiences resistance from the part of fixing and transfers to it the part of oscillations energy.

Using bearing structures of concrete, it is necessary to consider transverse (bending) oscillations occurred during operation and to test these structures for vibration robustness.

It is reasonable also to carry out monitoring of vibration environment in order to maintain continuous control over frequencies and amplitudes of oscillations in soil and structural elements of such constructions.

Finally, methods increasing dissipation of oscillation energy should be introduced wider in the civil engineering practice. It can be elastic joints between of large-size rigid elements, anti-vibration seams, dampening devices, etc.

Evaluation of damage from the accident with structure of unique covering of the Skating Center in Krylatskoe, Moscow, is presented by means of the risk monitoring.

Main tasks of the risk monitoring are:

- determination of the frequency of occurrence of initiating and undesirable events;
- evaluation of consequences of undesirable event occurrence;
- generalization of risk estimations.

Basing on the presented analysis, let's mark out the following possible reasons of an accident:

- errors during designing of steel structure;
- defects during manufacturing of steel structure;
- mistakes during installation of steel structure.

Practical tool for examination of construction hazards is quantitative risk analysis.

Conditional probabilities of an accident by the reasons of failure of the main elements of covering steel construction are determined under the method of "event tree" analysis.

Basing on the monitoring results and risk analysis, specific program of the most efficient measures to improve object protection against technogenic accident, i.e. program of optimal depletion of the preventive measures reserve, is proposed.

Analysis of losses demonstrates that compensatory payments related with human death are vastly superior to damage of other types.

It is resulted finally that anti-risk measures costing 7.6% of the object value will decrease the risk in 17 times. Real damage will be reduced in 34 times.

Such risk monitoring results will be demanded and efficient in the event of design errors, manufacturing defects, installation mistakes and in the field of insurance.