

CHAPTER 11 REMEDIAL MEASURES

11.1 Principles

(1) When a structure is assessed and judged as having a risk of performance degradation, appropriate remedial measures shall be selected in consideration of the maintenance category, remaining service period, and difficulty of maintenance.

(2) When carrying out the selected remedial measures, an appropriate plan for the measures shall be formulated considering the deteriorating mechanism and degree of deterioration of the structure.

(3) When planning remedial measures including the selection of methods and materials, target performance levels shall be appropriately defined.

(4) In cases when the deteriorating mechanism is clearly known, appropriate measures shall be selected considering the degree of deterioration, in accordance with Part 2 of this Specification.

(5) In cases when it is determined that the structure poses hazards for third party, appropriate remedial measures shall be taken immediately.

[Commentary] (1): Appropriate types of remedial measures should be selected when the evaluation/judgment concludes as follows: (i) One or more of the performances of the structure, such as performance over time, safety performance, serviceability performance, performance related to hazards for third party, and aesthetic appearance/landscape, has deteriorated to an unacceptable level; (ii) according to deterioration prediction, performance degradation will pose a problem before the end of the remaining service period, though currently there is no problem; and (iii) the rate of deterioration is significantly higher than initially predicted, causing performance degradation to pose a problem at an early stage. Selection of any of the measures specified in 11.2 as remedial measures is required.

When determining the necessity for remedial measures and selecting the type of such measures, it is necessary to consider the maintenance category and comprehensively investigate the remaining service period, life cycle cost, available budget, social impact of the structure, and ease of maintenance.

(2): Selection of methods and materials suitable for the relevant deterioration mechanism and degree of performance degradation is particularly important for measures for which wide varieties of methods and materials are available, such as repair and strengthening. Care should be exercised, as the method of restoring the performance may vary depending on the deterioration mechanism, even if the level of performance degradation is the same.

(3): Three target levels of performance are conceivable as shown in Fig. C11.1.1: (i) to restore a performance between the as-built and current performances, (ii) to restore the as-built performance, and (iii) to restore a performance higher than the as-built performance.

Table C11.1.1 classifies remedial measures based on the target performance level of the structure. When the remaining service period is short, it is possible to select materials and construction methods quite extensively. However, when the remaining service period is long, it is necessary to select construction methods and materials carefully. In some cases, it is best to carry out not only inspection but also experimental investigation. When it is difficult to select the construction methods and materials that guarantee the remaining service period, it is also necessary to select those providing the longest life from among the available construction methods and materials on the assumption that remedial measures will be carried out in the future.

Table C11.1.1 Remedial measures classified by target performance level

Performance	Target level		
	Performance between as-built and current performances	Same level as as-built performance	Performance higher than as-built performance
Durability	Repair	Repair/ Strengthening	Repair/ Strengthening
Safety		Strengthening	Strengthening
Serviceability		Serviceability restoration/ Strengthening	Functionality improvement/ Strengthening
Performance related to hazards for third party	Repair	Repair	
Aesthetic appearance/landscape		Appearance improvement	Appearance improvement

(4): The above items (1) to (3) describe the general issue of remedial measures without specifying a deterioration mechanism. On the other hand, when the deterioration mechanism is identified, the remedial measures are the same as those in items (1) to (3) in principle. In this case, the appropriate remedial measures based on the results of evaluation and judgment in accordance with especially **Part 2** “Standards for Maintenance” described for each deterioration mechanism shall be selected and then a plan of remedial measures shall be formulated accordingly. According to **Part 2**, in repair or strengthening, the appropriate construction methods and materials corresponding to the grade of deterioration can be selected more easily in conjunction with the setting of target performance levels.

The general concept of target performance levels is described in Commentary (3). For example, in a structure where the performance degraded due to chloride induced deterioration or carbonation, patch repair carried out by removing the peeling part usually corresponds to item of Commentary (3). In order to restore a structure to the level of item , a rigorous response of sufficiently removing the chloride ion and so on, among other measures, is required. Remedial measures that overlay a slab to bear heavy live load corresponds to item .

(5): Reasonable time is required for selecting the kind of remedial measures to use and for formulating a plan of remedial measures. However, when there is a high possibility of hazards for third party due to falling of concrete fragments, there is no time margin for selecting and carrying out the remedial measures. Therefore, it is necessary to carry out emergency measures, such as restriction in service, entry restrictions, and prevention of falling of concrete fragments by using a net and so on. After carrying out the emergency measures, an evaluation and judgment of performance are carried out, and then the appropriate remedial measures are selected and implemented. If necessary, the maintenance plan is also reviewed.

11.2 Types of remedial measures

Remedial measures shall be appropriately selected from among the following: “extensive inspection”, “repair”, “strengthening”, “appearance improvement”, “serviceability restoration”, “functionality improvement”, “usage restriction”, and “demolition/removal”.

[Commentary] The selections for safety performance include strengthening, intensified inspection, use restriction, and demolition/removal. Those for serviceability performance include strengthening, serviceability restoration, use restriction, intensified inspection, and demolition/removal.

Hazards for third party are generally addressed by repair.

11.2.1 Extensive inspection

Extensive inspection refers to an increase in the frequency and items of inspection from those given in the original plan. The actual extent of the increase in frequency and items of inspection shall be determined on the basis of the results of evaluation and judgment, and the remaining service period.

[Commentary] Intensified inspection refers to remedial measures carried out by increasing the inspection frequency and inspection items for structures to which no repair or strengthening is applied or those whose performance is assessed and judged as being possible to cause concern in the future.

11.2.2 Repair

Methods and materials for repair shall be selected considering the deterioration mechanism and post-repair maintenance. A repair plan shall be formulated based on the target levels of performances.

[Commentary] Repair includes (a) repair of defective events occurring in concrete structures, such as cracking and peeling, (b) removal of concrete involving deterioration factors due to chloride ion intrusion, carbonation, etc., and (c) surface coating to prevent re-intrusion of hazardous substances.