



## General Assembly

Distr.  
GENERALA/C.5/41/15  
15 October 1986

ORIGINAL: ENGLISH

Forty-first session  
FIFTH COMMITTEE  
Agenda item 110

## PROGRAMME BUDGET FOR THE BIENNIUM 1986-1987

Revised estimates under section 32. Construction, alteration,  
improvement and major maintenance of premisesEarthquake damage at the headquarters of the Economic Commission  
for Latin America and the CaribbeanReport of the Secretary-General

## INTRODUCTION

1. The main building at the headquarters of the Economic Commission for Latin America and the Caribbean (ECLAC) at Santiago, Chile, was built in the early 1960s following an architectural competition. The main building consists of a ring structure housing the office floor and a three-storey service block or nucleus building within the ring. The ring floor is completely suspended from large post-tensioned concrete girders. The ring is connected to the nucleus by four hanging bridges of varying length, also employing post-tensioned concrete girders. Two bridges are 23 metres long, weighing 155 tons, and the third is 28 m long, weighing 185 tons. The fourth is 6 m long. The sophisticated structural system employed for the building represented an advanced earthquake resistant-type structure. As such, it has behaved satisfactorily under seismic activity for two decades.

2. However, on Sunday, 3 March 1985, certain portions of the building suffered damages as a result of a severe earthquake of high intensity (7.4 to 7.6 on the Richter scale) and long duration (over three minutes) which affected the central zone of Chile. Fortunately, no staff were injured in the quake or in the after-shocks. The main structures withstood the effects of the strong earthquake remarkably well; neither the ring structure nor the nucleus building were affected directly. However, three of the four connecting hanging bridges sustained serious damage to their supports at each end and most of the bridge glazing was shattered, thus rendering the bridges unusable.

3. Also as a result of the earthquake, a portion of the ground floor plaza on the west side beneath the ring subsided. This subsidence and the movement of the ring floor overhead damaged the walls of the temporary offices in that location. It will be recalled that these offices had been added in 1970 under the main office floor on the south and west sides of the ring. Inexpensive, lightweight construction had been utilized to reduce costs. The offices were constructed with metal frames and glass partitions resting directly on the sidewalk slab without separate foundations and minimal connection to the underside of the ring slab above. Neither air-conditioning nor heating systems in compliance with building codes had been provided for these offices.

4. Immediately following the earthquake, action was taken to secure the bridges from further collapse by shoring them up with heavy timbers. All remaining glazing in the bridges were removed and the bridges closed to traffic. Likewise, the plaza area under the bridges was closed off. The glazed transoms of the partitions surrounding the temporary offices had shattered during the earthquake and these were replaced with hardboard. Other minor damage, mainly glass breakage, was sustained in the stair structure.

#### I. EVALUATION OF EARTHQUAKE DAMAGE AND RECOMMENDED SOLUTIONS

5. During the period following the earthquake on 3 March 1985 and until the end of August that year, a series of preliminary reports and assessments of the damage was prepared by various local engineering, architectural and construction firms which had been involved in the design and construction of the ECLAC building, as well as by the former chief of Buildings Management and General Services at ECLAC. These were reviewed and analysed by ECLAC and the Office of General Services at Headquarters and discussed with various consultants. Detailed information regarding the original construction was obtained from the European engineering firm that had been responsible for the construction and erection of the post-tensioned concrete superstructure.

6. Some of the experts and advisers consulted favoured immediate restoration of the bridges while others favoured their demolition and replacement. In view of the unusual structural design of the ring structure and the bridges, it was considered appropriate to determine whether the massive bridges should be raised and reinstalled or, alternatively, replaced completely by a lighter structure. Terms of reference were prepared by the Office of General Services for a study along these lines as well as a study of the condition of the plaza offices. Additionally, it was decided that the Assistant Secretary-General of the Office of General Services, Headquarters, should visit Santiago in August 1985 to observe and evaluate the damage at first hand, particularly, with a view to assessing the appropriateness of continued occupancy of the plaza offices and reviewing the necessary steps to investigate and implement the required bridge repairs.

7. As a result of this preparatory evaluation work, several studies were undertaken by:

(a) A team of engineers and technicians who participated in the construction of the building;

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(b) A team of consultants contracted from the Department of the School of Engineering of the University of Chile;

(c) A North American consulting firm specialized in seismic analysis.

8. The studies were divided into two basic areas of research (bridge repairs and rehabilitation of ground-floor office space) as follows:

(a) Bridge repairs

- (i) Phase I. Preliminary studies and preparation of a dynamic analysis and computer simulation of the building, to determine both resistance and compatibility of the separate structural systems under various earthquake conditions. Investigation of the feasibility of repairs and re-use of the damaged bridges as against, alternatively, the need for their replacement;
- (ii) Phase II. Preparation of final contract documents by a local consulting firm, based on the conclusions reached at in Phase I; and pre-qualification and selection of local contracting firms capable of executing the actual repair work;
- (iii) Phase III. Bidding process for contractual work; and execution of the repair project by the selected contractor;

(b) Rehabilitation of ground-floor office space

- (i) Preparation of an engineering evaluation of the ground floor office areas below the ring where the floor subsided, and recommendations on required corrective action. Review of construction problems related to these temporary offices;
- (ii) Review and recommendations on non-structural problems deriving from the earthquake and performance of a flood control study;
- (iii) Preparation of a detailed comparative study of the conversion into a permanent facility of the temporary office space on the ground level below the working floor, as opposed to the construction of a new low-cost building for the ground-floor offices.

9. Phase I of bridge repairs and the soils and flood studies associated with the rehabilitation of the ground-floor office space were undertaken in September 1985 by the consulting teams. Owing to the complex nature of the structures involved and their behaviour under seismic conditions, some six to eight months were required to complete the initial studies. During this period, a representative of the Office of General Services, Headquarters, visited Santiago twice, in December 1985 and in March 1986, for technical consultations and co-ordination with ECLAC officials and the consulting teams.

10. In June 1986, as a result of the floods and repeated minor earthquake shocks, the areas of the temporary offices on the ground floor under the ring sustained additional damage due to the progressive subsidence of the ground. Personnel in these offices had to be relocated to provisional areas and the affected structures were dismantled. Consequently, the team of consultants evaluating the ground floor areas had to revise their study based on the continuing instability of the ground.

11. As a result of the studies undertaken by the consultants, the following conclusions and recommendations were made:

(a) The damaged bridges, which are structurally sound but are at present supported by temporary shoring and are unusable, can be repaired and should be restored to their original condition with revised connection details to prevent a repetition of the recent damage;

(b) The rehabilitation of the temporary office space on the plaza level beneath the ring and its conversion into a permanent facility is feasible, but would involve major modifications, including removal of the present concrete slabs, excavation and recompaction of the soil underneath and construction of a proper foundation for the structure enclosing these offices.

## II. DESIGN AND CONSTRUCTION PROGRAMME

12. With the completion of the soils studies and the first phase of analysis and recommendations on the bridge repairs, the remaining phases of the final design and construction/repair works are now ready to be undertaken.

### A. Repair of Bridges and associated structures

13. As determined by engineering analysis, the damaged bridges can be repaired and preliminary structural solutions have been developed to that effect. Final design documents can now be prepared which will include engineering and architectural drawings and specifications for the repair work. The cost for these services is estimated at \$50,000 and would take approximately four months to complete.

14. Following the preparation of the design documentation, actual repair and construction work would be undertaken at an estimated cost of \$130,000. The time required to execute the repair work is an additional six months.

### B. Rehabilitation of ground floor offices

15. For the rehabilitation of the areas beneath the ring and conversion into a permanent facility of the temporary office space on the ground floor, which covers an area of 835 m<sup>2</sup>, the following major modifications have to be carried out:

(a) Demolition of existing concrete pad/walkway underlying the space;

- (b) Excavation and recompactation of the artificial fill under the proposed construction area;
- (c) Construction of a reinforced concrete foundation plus a reinforced floor slab and wall, as well as a roof structure independent of the ring building;
- (d) Reinstallation of electrical and other wiring to avoid safety hazards;
- (e) Provision of central heating and cooling;
- (f) Provision of sanitary facilities.

16. The financial implications of this plan have been estimated at \$230,000. The time-frame associated with this work is two months to complete drawings and specifications and six months for the actual construction work.

### III. CONCLUSION

17. It should be noted that the resources approved by the General Assembly for the 1986-1987 biennium for major maintenance at ECLAC (\$121,600) have already been fully committed and no savings are anticipated from within section 32 to cover the estimated cost of emergency repair work at ECLAC.

18. Consequently, in view of the serious rehabilitation work required at ECLAC headquarters as a result of earthquake damage, an appropriation of \$410,000 is requested under section 32, Construction, alteration, improvement and major maintenance of premises. This amount is broken down as follows:

- (a) \$50,000 for design documents, engineering drawings and specifications for repair of bridge work;
- (b) \$130,000 for actual repair and construction work on the damaged bridges;
- (c) \$230,000 for the rehabilitation of the ground floor offices under the ring.

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