CEP

CONSULTING ENGINEERS PARTNERSHIP LTD

CONCEPT
DAYRELLS ROAD
CHRIST CHURCH
BARBADOS W I
TEL (809) 426 5930
FAX (809) 426 5935
P O BOX 715 BRIDGETOWN
CABLES CONCEPT BARBADOS

DIRECTORS

TONY GIBBS, BSc DCT (Leeds), FICE FStructE MASCE
K M JOHNSON, OBE, BSc FICE FIWEM *
A E HUTCHINSON, BEng MASc MICE MStructE MIHT MCSCE
P T SOBERS MSc, DIC, MICE MStructE, MASCE
H E BROWNE BSc(Eng), MSc, MS, MICE
A C T FARRELL MSc FICE

CONSULTANTS

E R COX BEng, MICE
D E KEY PhD, BSc, FICE, FStructE, MASCE
C K CHU CHEONG, BSc, FICE FStructE MConsE

ASSOCIATE

B R NORVILLE, MSc *

HAZARD ABATEMENT PROJECT for DISASTER PREPAREDNESS in a CARIBBEAN ISLAND STATE

by
TONY GIBBS

Registered Professional Engineers (Barbados Act 1975 - 11)
Members of the Barbados Association of Professional Engineers

HAZARD ABATEMENT PROJECT FOR DISASTER PREPAREDNESS

Introduction

Does your disaster preparedness plan assume the full utilisation of existing hospitals? What would happen if fire engines cannot exit from their garages? How essential are internal and external telecommunications? Does your plan require the post-disaster functioning of power plants, water supply systems and sewage treatment plants?

In any community (andBarbados is no exception) many or most of the existing buildings pose potential hazards in the event of a natural disaster. Remedial action by Government agencies for structures they are responsible for would considerably mitigate future losses. Vital facilities necessary for providing immediate post-disaster relief such as hospitals, emergency communications centres, schools and public utilities should be given high priority.

Hazard mitigation for new construction is relatively easily achieved through the use of up-to-date standards and specifications. However, many existing buildings do not incorporate hazard mitigation provisions. Where such buildings are regarded as post-disaster assets their suitabilities for their tasks have a direct bearing on the effectiveness of any disaster preparedness plan.

It is recognized that a programme to bring about the correction of difficiencies in all essential facilities within a 5-year plan is neither physically nor economically feasible. Such a programme is best carried out in accordance with a rational process over a period of the order of one generation (say 25 years). The plan which follows deals with the first 5 years of the overall programme.

Outline of the Plan

The programme of hazard abatement for buildings required for post-disaster relief purposes after hurricanes, earthquakes and floods could include the following steps:

1. List those buildings and facilities which are important.

2. Carry out qualitative assessments of the facilities listed in 1. This would establish which facilities are obviously satisfactory and those which are obviously not satisfactory.
3. Carry out analytical evaluations of all the other (i.e. doubtful) facilities listed in 1.
4. Embark on a programme of reduction or removal of hazards where these are shown to exist. Such a programme would follow a priority listing of facilities requiring improvement.

It is suggested that the work to be accomplished in the first 5 years includes all of items 1 and 2, and items 3 and 4 only for 20% of the most important buildings and facilities. A likely timetable for the 5-year plan is attached to this presentation.

Selection of Buildings for Evaluation

It is suggested that CERO produce the first list of buildings based on use and occupancy (number of occupants). Such a list could have the following classifications:

Class A (Facilities which must remain operational during and after a disaster):
Hospitals, police stations, fire stations, essential communications, power plants, water plants

Class B (Other essential facilities):
Institutions for incapacitated, orphanages, nursing homes, schools, detention and correctional. High-occupancy places such as schools, theatres, shopping centres and high-rise buildings. Hazardous uses - industrial (production) and commercial (storage). Buildings in the "inner fire district".

Class C (All other buildings other than single or two-family dwellings).

This long list of facilities would be circulated to the various Government ministries and agencies and to relevant non-government organisations for comment and pruning. The short list for qualitative evaluation will then be prepared by CERO.

(Note: It is intended that the parties carrying out the subsequent phases of the plan participate in the selection process outlined above).

Other approaches to selection may involve considerations such as balanced risk of damage, cost-effective level of abatement and remaining life expectancy of facilities. Such approaches would need (inter alia) the results of the qualitative and analytic evaluations. However it would be useful to discuss these "economic" considerations here.

Benefit-Cost Studies

Benefit-cost studies can be usefully employed in assisting in developing and implementing a hazard reduction programme. It is not feasible economically to elliminate the ill effects of natural hazards. Hence it is neccessary to decide how much of the country's resources should be devoted to mitigating natural disasters and to choose the most effective methods.

Benefit-cost studies themselves do not make decisions. They are a tool for analysing a wide range of facts and assumptions and for demonstrating the implications of alternative strategies. The usefulness of such studies is closely related to the validity and completeness of the data and assumptions. It would be useful however to start with simple (and possibly crude) measures of the hazards to buildings to test the procedures and to develop confidence in the tool. The Government could initiate studies and programmes to develop and collect data concerning the many less immediate and often intangible costs of disasters eg. loss of productivity, loss of tax base and the psychological and economic impacts on the community.

Technical Selection

The above methods of selection of buildings for analysis are based largely on non-engineering criteria — use, occupancy, economics. Ignoring the above, there can be a purely engineering or technical approach to the selection of buildings for evaluation. This is demonstrated by Flow Chart 1 which accompanies this document.

In the chart "seismicity index" refers to the level of seismic risk in the area as defined by the document ATC-3 (see references at the end of this submission), "seismic performance categories" takes into account the importance of the facility (see ATC-3) and "OP" is the occupancy potential of the building.

Qualitative Evaluation

This level of evaluation does not envisage exhaustive testing of materials in place nor sophisticated computation of stresses. It does involve a careful review of all readily available data such as drawings, an inspection of the building without destructive testing and a non-mathematical analysis of the data. By its very nature this qualitative evaluation requires the exponent to have a greater degree of knowledge about the effects of natural hazards on facilities and a greater maturity of engineering judgement than any of the other functions in this programme.

Flow Chart 2 which accompanies this document sets out an appropriate methodical approach to qualitative evaluation. In this chart t_x is the length of time in years permitted for the abatement of potential hazards in the facility. The term α_t is a factor determined by policy makers (in this case Government) but is likely to be in the range of 20 to 35. (A typical value for a North American community would be 12). It is a measure of the number of years within which a community wishes to put its house in order. The term r_c is the ratio of the existing "strength" of the facility to the desired "strength".

Priority Rating

Many factors will come into play for this aspect of the programme and most of these factors will not be of a strictly technical nature. However it would greatly assist the exercise if certain objective and technical procedures were introduced as tools.

Such a tool is the determination in a uniform manner of the length of time that should be allowed to bring each facility up to the desired level of safety. Then those facilities with the shortest times would have the highest priority.

Figure 1, "Permissible Time for Hazard Abatement", illustrates the approach. "Capacity ratio" (r_c) was introduced in the previous section of this document. "Time to strengthen or abolish" (t_x) was also introduced in that section. For the purposes of this exercise, the graphs A, B and C can be taken as relating to the different classes of buildings described in the earlier section "Selection of Buildings for Evaluation". The values are leniency ratios. The smaller the ratio the less lenient the community can be in judging the facility. In Figure 1, the suggestion is that all class A buildings must be brought up to mark in 15 years, class B in 25 years and class C in 35 years. The actual figures to be used will of course depend on Government policy.

Analytical Evaluation

Facilities whose performances are deemed to be doubtful, when evaluated qualitatively, will be subjected to an analytic evaluation. Since this is a time-consuming and therefore expensive exercise it would be appropriate to carry it out only when the funds were available for implementing the possible action indicated by this evaluation.

The proceedure is illustrated diagramatically by Flow Chart 3. All the terms in that chart have been previously described.

In the suggested 5-year Plan only 20% of the critical facilities (post-disaster assets) will be subjected to this evaluation.

Reduction or Removal of Hazards

This is the physical implementation phase of the programme. In the proposed 5-year Plan work would be limited to 20% of the post-disaster assets.

This phase of the programme follows the normal construction project route of preparation of tender and construction documents, procurement of a contractor and implementation of the works on site. In this case the works would consist of retrofitting of the existing facilities.

Costs

The budget for the overall programme, and indeed for the 5-year plan, would be determined by policy makers. However, little impact can be made below a certain level of expenditure. Dealing only with items 1 and 2 in "Outline of the Plan", would warrant an expenditure of between $50 000 and $100 000 per year. The lower figure is considered a minimum to permit the programme to have a noticeable impact on disaster planning.

The budget for items 3 and 4 of the Plan cannot be established at this time. Since item 3 does not start until the beginning of the second year and item 1 ends 6 months earlier there would be the time to develop budgets for items 3 and 4.

Pilot Programmes

In a sense the 5-year Plan described above constitutes a pilot programme, especially in respect of items 3 and 4 of the Plan. However an even smaller pilot programme could be designed. Such a programme could have as its aim the seeking of funding for the larger exercise.

References

Building Practices for Disaster Mitigation
- US National Bureau of Standards

Evaluation of Earthquake Safety of Existing Buildings
- B Bresler

Tentative Provisions for the Development of Seismic Regulations for Buildings (ATC-3) - NSF/NBS, USA.

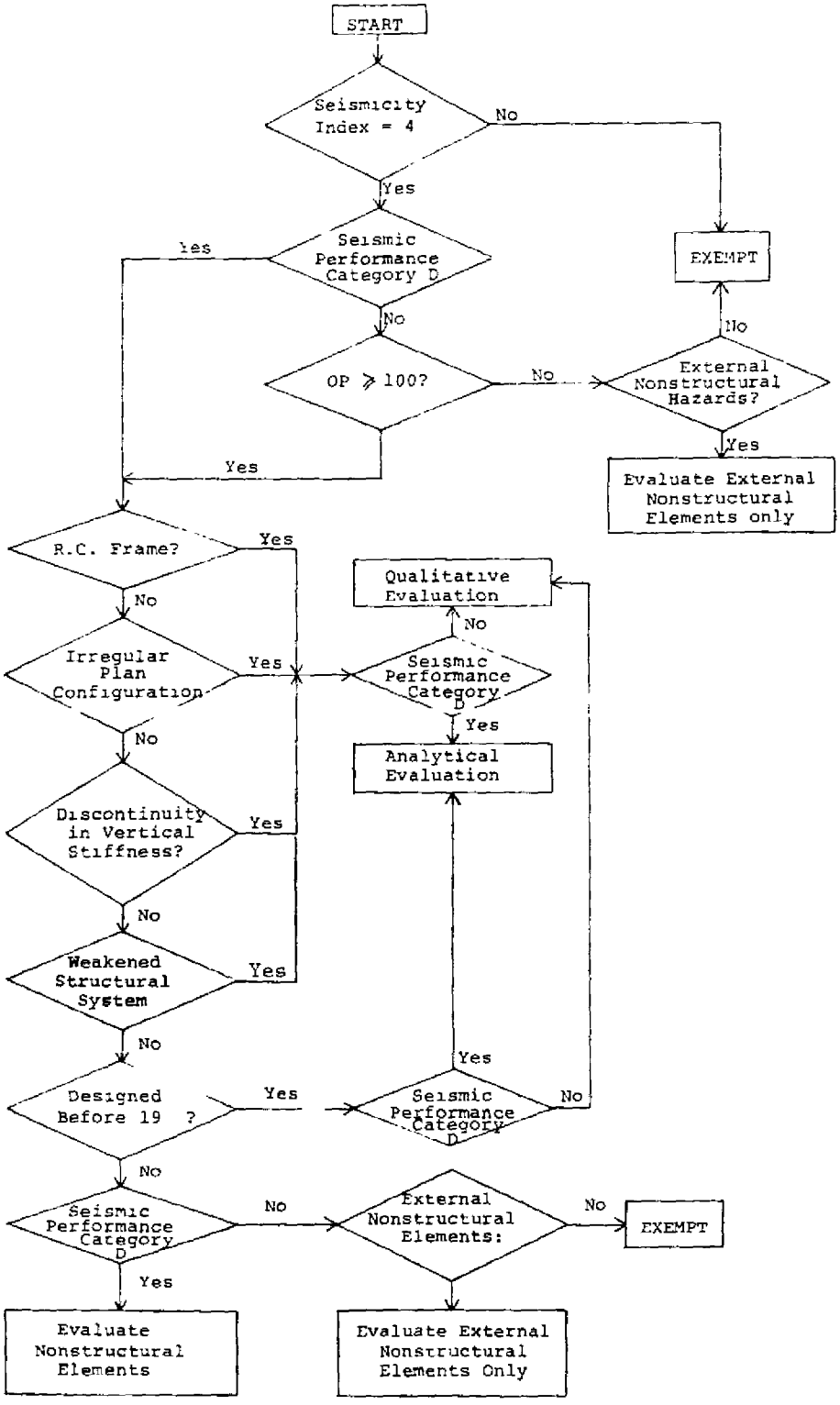
Accompanying Documents

Gantt Chart for 5-Year Plan
Flow Chart 1: Selection of Buildings for Evaluation
Flow Chart 2: Qualitative Evaluation
Flow Chart 3: Analytical Evaluation
Figure 1 : Permissible Time for Hazard Abatement

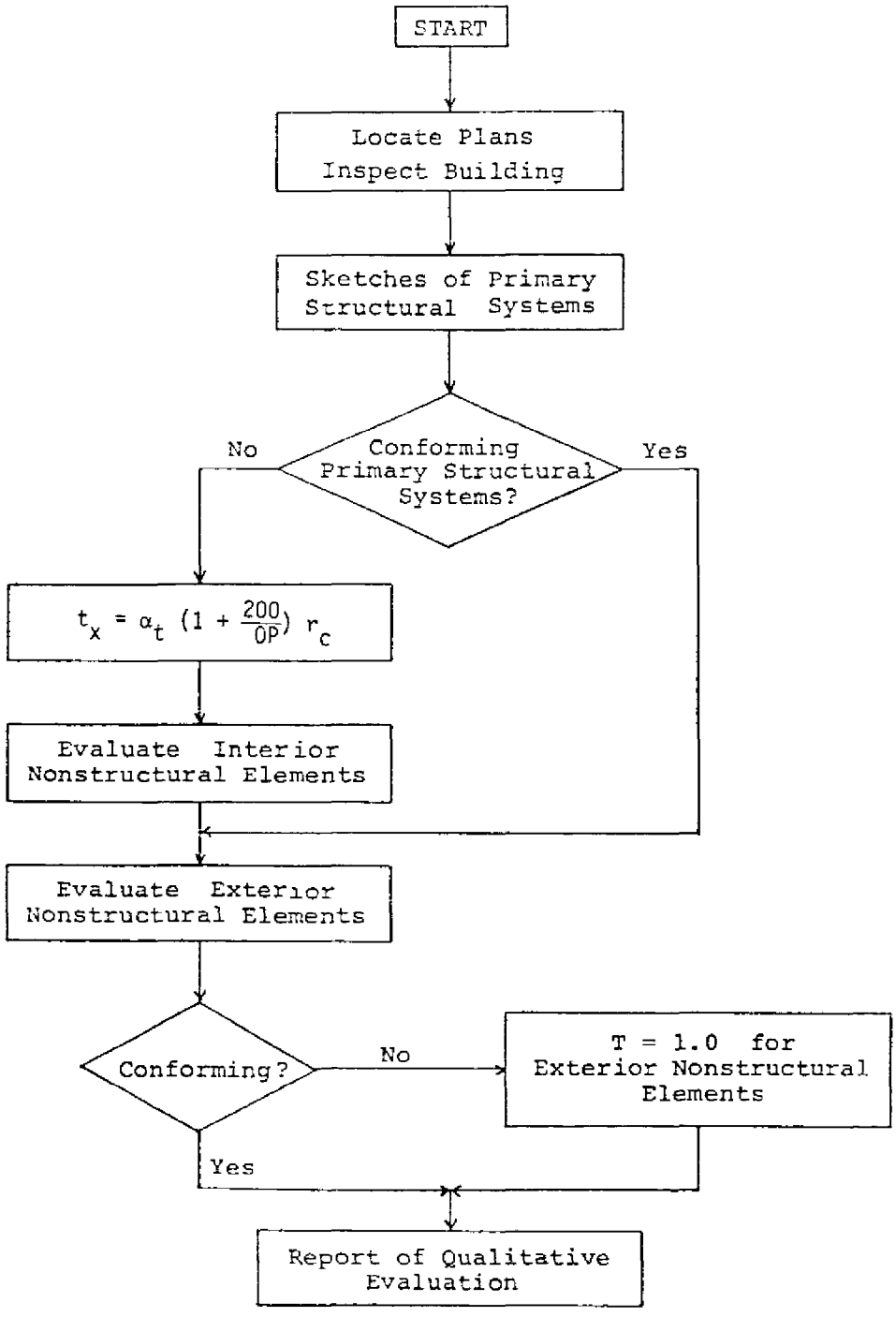
GANTT CHART FOR 5-YEAR PLAN

Item	beginning of April in year: 91	92	93	94	95	96
1. Selection of buildings for evaluation	xxxxxx					
2. Qualitative evaluation and priority rating		xxxxxxxxxxxxxxxxxxxxx				
3. Analytical evaluation			xxxxxxxxxxxxxxxxxxxxxxxxxxx==========: 20% most important facilities			
4. Reduction or removal of hazards				xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx====== 20% most important facilities		

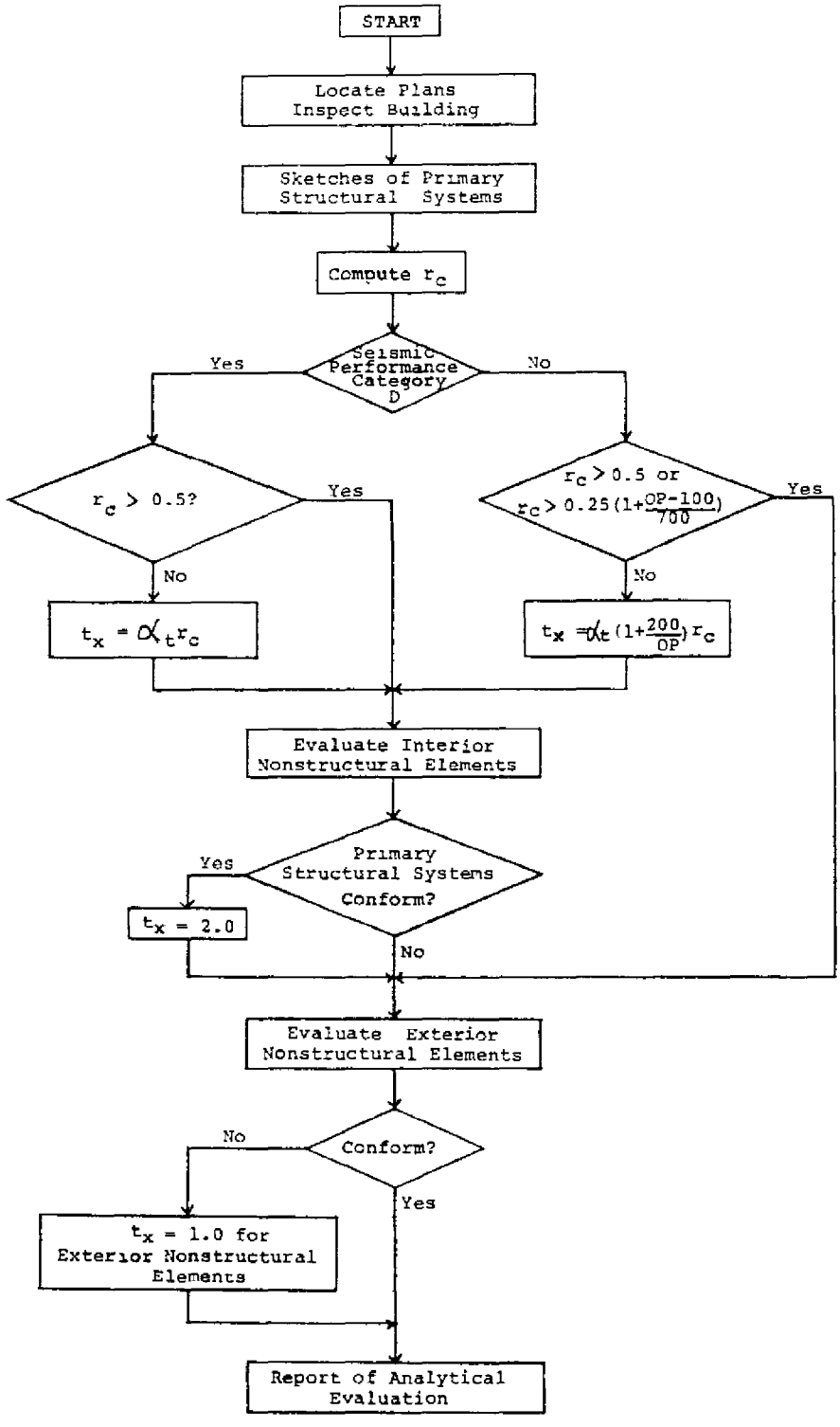
FLOW CHART 1 : LECTION OF BUILDINGS FOR EVALUATION



FLOW CHART 2 : QUALITATIVE EVALUATION



FLOW CHART 3 . ANALYTICAL EVALUATION



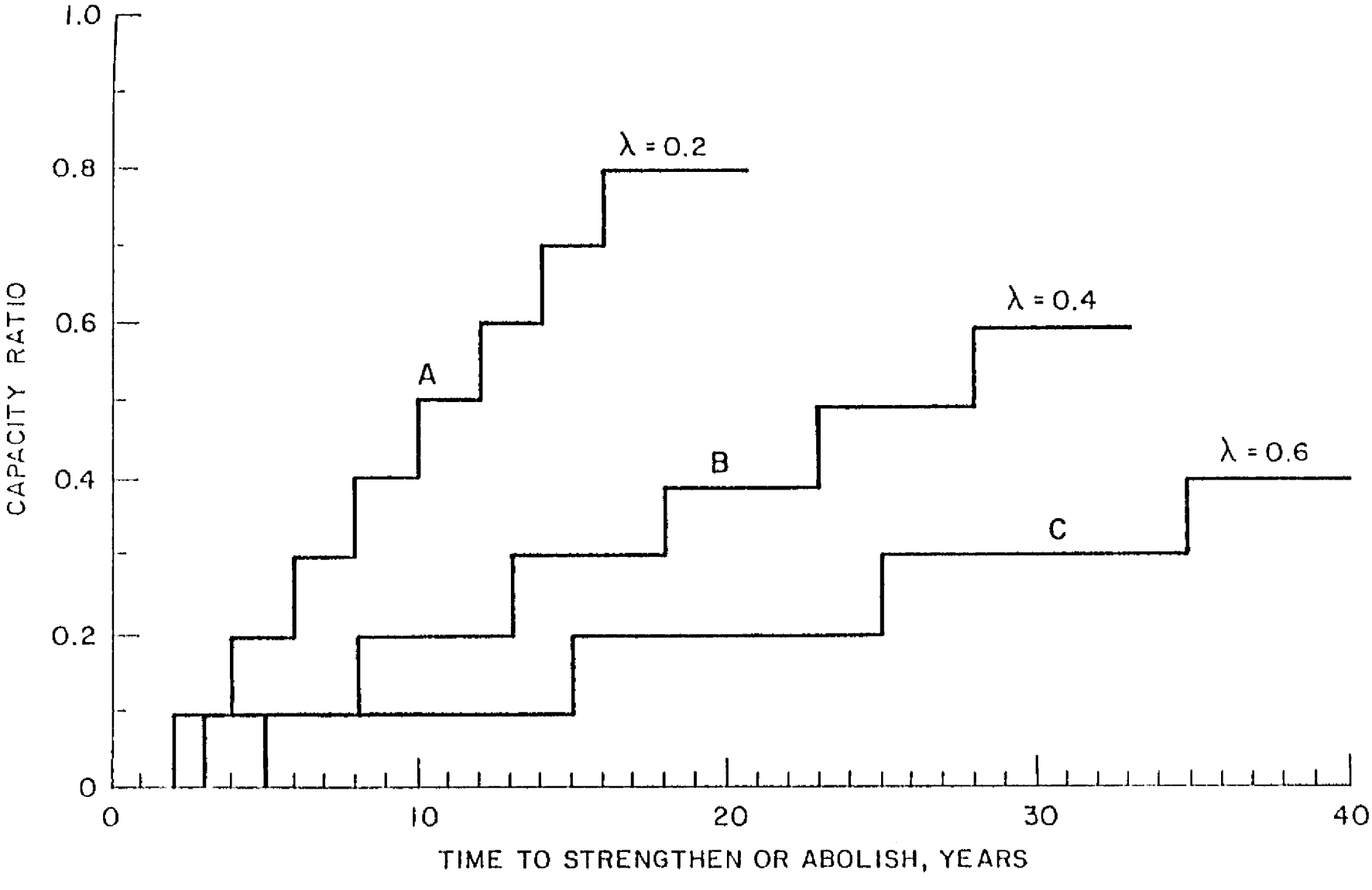


FIGURE 1 PERMISSIBLE TIME FOR HAZARD ABATEMENT