SECTION 12

LOADS

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1201 GENERAL

1201.1 Definitions

(a) Corridor means a path of egress connecting more than one room or occupied space on any floor - a hallway.

(b) Dead load means the weight of walls, floors, roofs, partitions and other permanent constructions.

(c) Flat roof means a roof having no inclination or having an inclination of not more than 10 degrees with the horizontal.

(d) Live loads means all loads other than dead loads, wind loads and earthquake loads.

(e) Load bearing means any part of a building (including the foundation) bearing a load other than that due to its own weight, earthquake forces and to wind pressure on its surface.

(f) Pitched roof means a roof having an inclination of more than 10 degrees with the horizontal.

g) Class of Load defines the minimum uniformly distributed load to be applied for floors with the occupancy as stated for each particular class.

1201.2 Basis of Design

(a) Any system or method of design or construction shall admit of a rational analysis in accordance with well established principles of mechanics and sound engineering practices.

(b) All buildings and structures and all parts thereof shall be designed and constructed to be of sufficient strength to support the estimated or actual imposed dead, live, wind and any other loads both during construction and after completion of the structure, without exceeding the stresses for the various materials specified in this Code. The designer shall consider the possibility of extraordinary concentrated loads being applied to the system.

(c) All floor and roof systems shall be designed and constructed to transfer horizontal forces to such parts of the structural frame as are designed to carry these forces to the foundations.

1201.3 Unit Dead Loads

The unit weights of basic materials used in the calculation of dead loads shall preferably be based on properly substantiated information. Where this is not available, the values given in the latest addition of BS 648 "Schedule of weights of building materials" or an equivalent authoritative standard shall be used. Appendix E provides the approximate weight of building material commonly used in the Caribbean. It should be noted that the weight of concrete block, plain and reinforced concrete varies with the type of aggregate and with the amount of reinforcement used.

1201.4 Unit Live Loads

Table 12-1 shall be used to determine the minimum live loads to be imposed on various types of floors. These loads shall be applied in such a manner as to produce the most severe stresses.

In designing floors of classes 30 and 40, provision shall be made for a concentrated load of 315 lbs. placed on any 1 ft. square area wherever this load will produce stresses greater than those caused by the uniformly distributed load.

1201.5 Special Loads

(a) No building or part thereof shall be designed for live loads less than the loads specified in 1201.4.

(b) The live loads set forth therein shall be assumed to include ordinary impact but where loading involves unusual impact the necessary allowance shall be made by increasing the assumed live load.

(c) Provisions shall be made in designing office floors and class 50 garage floors for a load of 2,000 lb. placed upon any area 2' 6" square wherever this load upon an otherwise unloaded floor would produce stresses greater than those caused by a uniformly distributed load of 50 lbs per sq.ft.

(d) In designing floors, not less than the actual live load to be imposed shall be used in the design. Special provision shall be made for machine or apparatus loads. Consideration should be given in the design of living rooms where crowded conditions are likely to occur during parties and dances.

(e) Tanks and their contents should normally be treated as dead load.

(f) Where partitions are shown on the plans their actual weights should be included in the dead load. To provide for partitions where their positions are not shown on the plans, the beams and the floor slabs where these are capable of effective lateral

distribution of the load, should be designed to carry in addition to other loads. a uniformly distributed load per sq.ft. of not less than 10 percent of the weight per foot run of the finished partition, but not less than 20 lb./ sq.ft. if the floor is used for office purposes. Where such effective distribution is not provided (e.g in the case of precast slabs without topping concrete) special provisions shall be made.

(g) Floors in garages or portions of buildings used for the storage off motor vehicles shall be designed for the uniformly distributed live loads shown in Table 12-1 or the following concentrated loads: See Table 12-1(A).

i) for passenger cars accommodating not more than nine passengers, 2,000 lbf acting on an area of 20 sq.in.

ii) mechanical parking structures without slab or deck, passenger cars only, 1,500 lbf per wheel.

iii) for trucks or buses, maximum axle load on an area of 20 sq.in.

(h) Corridors and balconies shall normally be designed for the same class of loading as the floor or other space to which they give access.

(i) Table 12-2 shall be used to determine design live loads on stairs and landings.

1201.6 Parapets, Balcony Handrails and Balustrades.

a) The minimum specified load applied horizontally and normal to the span at the top of every required guard shall be:

USE	**Horizontal Load lb/ft run**
Light access stairs, gangways and the like not more than 2 ft. wide	15
Light access stairs, gangways and the like more than 2 ft. wide, stairways, landings and balconies	40 plus concentrated load of 60 lbs
All other stairways, landings and balconies and all parapets and handrails to roofs	40 to 60 (exits and stairs)
Grandstands and stadia	250

b) For the loading on vehicle barriers for car parks see 2.109 of CUBiC.

c) In all cases, the wind load, if greater in effect, must be allowed for.

1201.7 Roof Live Loads*

(a) Table 12-3 shall be used to determine roof live loads for design purposes.

(b) The combined effect of dead and live loads on roofs shall be taken into account.

(c) Roof covering. To provide for loads incidental to maintenance, all roof covering (other than glass) at a slope less than 45 degree should be capable of carrying load of 200 lb. concentrated on any 8" square at normal stress.

***Note: Live loads do not include wind and earthquake loads.**

1201.8 Live and Dead Load Reductions

(a) Table 12-4 shall be used to determine the permitted reductions in assumed total live floor loads to be taken in design of columns, piers, walls, their supports and foundations, except as provided for in (b) and (c).

(b) No reduction should be made for floors of factories and workshops designed for less than 100 lb./ sq.ft. live loading or for any buildings for storage purposes, warehouses and garages. For factories and workshops designed for 100 lb. per sq. ft. or more, the reductions shown in Table 12-4 may be taken provided that the loading assumed for any column, etc. is not less than it would have been if all the floors had been designed for 100 lb/sq.ft with no reductions.

(c) Where a single span of a beam or girder supports not less than 500 sq. ft of floor at one general level the live load taken in the design on the beam or girder may be reduced by 5 percent for each 500 sq.ft supported, subject to a maximum reduction of 25 percent. This reduction or that given in Table 12-3, whichever is greater, may be taken into account in the design of columns etc. supporting such beam but should not be made where the floors are used for storage purposes nor in the weight of any plant or machinery which is specifically allowed for.

1201.9 Posting of Live Load Notices

In all cases of Group A buildings (301.2) the Director may require the owner(s) to fix in a conspicuous position on each floor, plaques stating the permitted live load and the permitted occupancy intent of that floor or of that part of that floor.

1202 WIND LOADS

1202.1 Basis of Design

(a) Buildings and structures shall be designed and constructed to resist the forces due to wind pressure. The forces exerted by the wind on a building are the result of a combination of factors such as wind speed, exposure factor, aerodynamic shape of the structure, and dynamic response factor.

(b) Such forces shall be applied with all possible combination of loadings, such combinations shall include the case of dead loads plus wind loads only. In the special case of roofs, in no case shall any roof be designed for live loads less than those specified in Table 12-3 but the said live load need not be considered to act simultaneously with the wind load.

(c) Structural systems shall be designed and constructed to transfer wind forces to the ground.

1202.2 Wind Pressure

(a) The effect of wind pressure on buildings and structures and parts thereof shall be determined from Part 2 Section 2 of the Caribbean Uniform Building Code.

(b) The design engineer may utilise a design based on other internationally recognised and accepted information on the effects of wind on structures subject to the approval of the Director.

1202.3 Overturning Moment and Uplift

(a) Where the overturning moment on a building or other structure exceeds two-thirds of the moment of stability computed from dead load only, anchorage to resist the excess over two-thirds of the dead load moment of stability shall be provided.

(b) Where the uplift on a building or other structure, or portion thereof, exceed two-thirds of the dead load only, anchorage to resist the excess uplift over two-thirds of the dead load shall be provided.

1202.4 Stresses due to Wind Loading

For members carrying wind stresses only, and for combined stresses due to wind and other loads, the allowable unit stresses and the allowable loads on connections may be increased by one-third of the maximum working stress specified in this Code for the materials used, except for the provisions of Section 16 - Plain and Reinforced Concrete. Such increases shall not apply to towers, cantilevered projections or metal sheathing where vibrating or fluttering action could be anticipated.

In no case shall the section be less than required if the wind stresses be neglected .

1203 EARTHQUAKE LOADS

1203.1 Basis of Design

a) The record of seismic activity within the last 100 years shows that there have been earthquakes which have created significant damage in some of the islands in the Eastern Caribbean. In the past twenty-five years Islands such as Antigua, St. Kitts and Montserrat have experienced earthquakes which have caused damage to buildings and other property.

b) It is necessary therefore that every building and structure and every portion thereof be designed and constructed in accordance with Part 2 Section 3 of the Caribbean Uniform Building Code (CUBiC) or in accordance with any other Code or Standard approved by the Director[1].

c) For the design of small buildings to resist seismic forces see Section 18 of this Code and Section A of the Building Guidelines.

1203.2 Building Response Data from Future Earthquakes

In order to develop earthquake resistant design recommendations more specific to each of the OECS, building response data must be obtained from future earthquakes. The installation of at least three strong motion accelerographs is recommended in all buildings six storeys or more in height. Where provided, accelerographs are to be distributed between ground and roof.

1204 LOAD TESTS

1204.1 Conditions Requiring Load Tests

Whenever there is insufficient evidence of compliance with the provisions of this Code or evidence that any material or any construction does not conform to the requirements of this Code, or in order to substantiate claims for alternate materials or methods of construction, tests as proof of compliance shall be made by an agency approved by the Authority and at the expense of the owner.

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[1] *The appropriate zonal coefficient for St. Lucia taken from Table 2.305.1 of CUBiC is 0.75*

1204.2 Acceptability Criteria

a) Where there is no recognised standard test procedure for the material or assembly in question, the material or assembly under dead plus live vertical load shall deflect not more than 1/240 of the span, nor more than 1/360 where required to support a plaster ceiling or brittle partitions, and that the material or assembly shall sustain dead plus twice the live load for a period of 24 hours, with a recovery of at least 80 percent.

b) Where elements, assemblies or details of structural members are such that calculation of their load-carrying capacity, deformation under load or deflection cannot be made by rational analysis, their structural performance shall be established by tests in accordance with test procedure as developed by the design engineer based on consideration of all probable conditions of loading.

1205 DIFFERENCES BETWEEN WIND AND EARTHQUAKES

Table 12-5 shows the main differences between wind and earthquakes on the design of a building. It will be noticed that the predictability of loads from wind pressures is usually good, while the loads from earthquakes cannot be readily assessed. The building frames to accommodate earthquake loads must be provided with ductility while for wind the buildings do not have to be designed on the basis of the same criteria, as the main factors affecting building response are the external shape and size of the building.

Table 12-1

Floor Loads

Loading Class Number	Types of Floors	Minimum Imposed Loads	Alternative Imposed Loads (lb)	
		Slabs	Beams	Beams
		lb. per sq.ft.of floor area	Uniformly distributed over span, per ft width	Uniformly distributed over span
30	Floors in dwelling houses of not more than 2 storeys	30	240	1,920
40	Floors (other than those of class 30) for residential purposes including dwelling houses of more than one occupation· residential flats; hospital wards; hotel bedrooms and sitting rooms; rest rooms institutional establishments of Group B occupancy.	40	320	2,560
50	Floors of light work rooms without storage; floors of garage for passenger cars with gross weight not exceeding 2-1/2 tons	50	As required by 1201.5 (c)	As required by 1201 (c)
60	Floors of school class rooms; office ground floor and office floors below ground floor; floors of banking halls; floors of library reading rooms: marques, hospital operating theatres	60	480	3,840
70	Office floors	70	560	4,480
80	Shop floors used for the display and sale of light merchandise; workrooms generally; garages for vehicles exceeding 21 tons gross weight; places of assembly with fixed seating; churches and chapels. restaurants; circulation space in machinery halls, power stations etc. where not occupied by plant or equipment, theatre balconies with fixed seating; city halls, court houses, art galleries.	80	640	5,120

Note Fixed seating implies that the removal of the seating and the use of the space for other purposes is impossible

Table 12-1 (Cont'd)

Floor Loads

Loading Class Number	Types of Floors	Minimum Imposed Loads	Alternative Imposed Loads (lb)	
		Slabs	Beams	Beams
		Lb. per sq.ft. of floor area	Uniformly distributed over span, per ft. width.	Uniformly distributed over span
100	Floors of warehouse, workshops, factories, and other buildings or parts of buildings of similar categories for light-weight loads; places of assembly without fixed seating; public rooms; dance halls; theatre balconies without fixed seating; gymnasiums. Assembly platforms; composing and linotype rooms in printing plants, reviewing stands and bleachers, drill rooms; fire escapes; hospital X-ray rooms; laboratories, cinemas public auction rooms not used for storage of goods.	100	800	6,400
100A	Areas used for general storage and filing purposes in offices of loading class 50 and 70. Note: Special consideration shall be given to the average and the localized floor loadings Class 70, used for heavy filing and storage equipment (such as card cabinets and rolling storage units, and for centralized security and storage.)	100	800	6,400
150	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar categories for light weight loads; floors of garages for vehicles not exceeding 4 tons gross weight; stages, armouries.	150	-	-
200	Floors of warehouses, workshops, factories, other buildings or part of buildings of similar categories for heavy weight loads (unless actual loading is greater than 200 lb/sq.ft); floors of book stores; museums.	200	-	-

Table 12-1(A)

Minimum Concentrated Loads

Location	Load (lb.)
Elevator machine room grating (on area of 4 sq.in)	300
Finish Light floor plate construction (on area of 1 sq. in)	200
Garages	(see 1201 5(g)
Office Floors	2,000
Accessible ceilings	200
Sidewalks	8,000
Stair treads (on area of 4 sq.ins at centre of tread)	300

Note: Table 12-1(A) taken from ANSI A58.1 1982

Table 12-2

Design Loads for Stairs and Landings (other than fire escapes)

Class of Floor Served	Live Load (lb/sq.ft.)
30	30
40, 50, 60, 70	60
Other classes	100

Consideration shall be given to increasing the design loading where there is a possibility of heavy equipment being transported on stairs or landings.

The following minimum concentrated loads shall be considered on stairs and landings at the most unfavourable positions for bending moment and shear.

Loading Class 30:	400 lb.
Class 40,50 & 60 :	600 lb.
Class 70 :	600 lb.
Class 80,100, 150 & 200:	1,000 lb.

Table 12-3

Roof Live Loads. Design Loading lb/sq ft of Plan Area

Slope of Roof	With Access	No Access
Up to 10 degrees	30	15
Over 10 degrees up to 30 degrees	15	Nil
Over 75 degrees	Nil	Nil

For slopes between 30 degrees and 75 degrees the imposed load to be allowed for shall be obtained by linear interpolation between 15 lb. per sq. ft for a 30 degree slope and nil for a 75 degree slope

NOTE:

"With access" means access in addition to that necessary for cleaning and repair

"No access" means no access other than that necessary for cleaning and repair.

The design loading in this Table does not include wind or earthquake loads.

Table 12-4

Reductions of Total Live Floor Loads on Columns.

Number of floors carried by member under consideration	Percent reduction of live load on all floors above the member under consideration
Roof	0
Roof and two floors	0
Roof and three floors	10
Roof and four floors	30
Roof and five floors	40

Table 12-5

Main Differences between Wind and Earthquakes

Item	Wind	Earthquakes
Source of loading	External forces due to wind pressure	Applied movements from ground vibration
Type and duration of loading	Wind storm of several hour's duration; loads fluctuate, but predominantly in one direction	Transient cyclic loads of at most a few minutes' duration; loads change direction repeatedly
Predictability of loads	Usually good, by extrapolation from records or by analysis of site and wind patterns	Poor; little statistical certainty of magnitude of vibrations or their effects
Influence of local soil conditions on response	Unimportant	Can be important
Main factors affecting building response	External shape and size of building, dynamic properties unimportant except for very slender structures	Response governed by building dynamic properties: fundamental period, damping and mass
Normal design basis for maximum credible event	Elastic response required	Inelastic response Permitted, but ductility must be provided; design is for small fraction of the loads corresponding to elastic response
Design of non-structural elements	Loading confined to external cladding	Entire building contents shaken and must be designed appropriately