Multi-hazard Building Design Course
(focussing on wind and earthquake forces)

Post-Georges Disaster Mitigation Project
in Antigua & Barbuda and St. Kitts & Nevis

November 2000

Post-Georges Disaster Mitigation in Antigua & Barbuda and St. Kitts & Nevis is implemented by the Organization of American States, Unit for Sustainable Development and Environment for USAID-Jamaica/Caribbean Regional Program

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This course was developed under contract with the OAS by Tony Gibbs, with contributions by Anthony C T Farrell, for the Council of Caribbean Engineering Organisations.

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developed by
Tony Gibbs

Preamble

The course is designed so that it can be delivered in two modules:

A The first module consists of:
1. Hurricane and earthquake hazards in the Caribbean
2. Multi-hazard design – synergies and contradictions
3. Conceptual designs to resist hurricanes and earthquakes

B The second module consists of:
1. Determination of forces for use in analysis
2. Outline of analytical procedures
3. Detailing

Those not directly involved in designing or checking structures may wish to take the first module only. Those directly involved in the design of structures (either as designers or checkers) would want to take both modules. Those taking the second module are required to take the first module.

Outline of the Course

The itemised outline of the timetable (including days, time periods, subjects and presenters or participants) is shown is the following table. (The dates shown are for the inaugural course which took place at the Ocean Terrace Inn, St Kitts.) The main presenter for the inaugural course was Tony Gibbs (assisted by Anthony Farrell). Subsequent courses may be presented by others, either as sole or multiple presenters.

Day/Time	Subject	Presenter
Day 1 (13Nov2000)		
	A1 Hurricane and Earthquake Hazards in the Caribbean	
08:30-10:00	*A1.1 The Hurricane Hazard* A1.1.1 formation A1.1.2 climate change and its effect on the windstorm phenomena A1.1.3 factors affecting the wind speed A1.1.4 factors in determining the effect of wind on buildings A1.1.5 examples of failures	Tony Gibbs
10:00-10:30	Refreshments	
10:30-12:00	*A1.2 The Earthquake Hazard* A1.2.1 the tectonic setting of the Caribbean A1.2.2 seismic events in the Caribbean – causes and history A1.2.3 Seismic Research Unit of UWI and the engineering community A1.2.4 the Pan-American Institute of Geography and History project A1.2.5 the USAID/OAS-CDMP project results and derived "code" values A1.2.6 volcanic activity A1.2.7 tsunamis	Tony Gibbs
12:00-13:30	Lunch	
	A2 Multi-hazard Design	
13:30-15:00	*A2.1 Synergies and Contradictions* A2.1.1 source of loading A2.1.2 type and duration of loading A2.1.3 predictability of loads A2.1.4 influence of local soil conditions on response A2.1.5 main factors affecting building response A2.1.6 normal design basis for maximum credible event A2.1.7 design of non-structural elements	Tony Gibbs
15:00-15:30	Refreshments	
	A2.2 The Process of Structural Design	

15:30-17:00	A2.2.1 forms and systems and materials A2.2.2 the influence of available construction processes A2.2.3 accommodation of the legitimate requirements of the architect and the electrical and mechanical engineers A2.2.4 ancillary issues A2.2.5 the need to satisfy the contractor A2.2.6 the need to satisfy the investor	Tony Gibbs
Day 2 (14Nov2000)		
	A3 Conceptual Design	
08:30-10:00	*A3.1 Conceptual Designs to Resist Hurricanes* A3.1.1 geometry or shape or configuration of the building A3.1.2 the siting of the building A3.1.3 the materials of construction A3.1.4 the structural system	Tony Gibbs
10:00-10:30	Refreshments	
10:30-12:00	*A3.2 Conceptual Designs to Resist Earthquakes* A3.2.1 geometry or shape or configuration of the building A3.2.2 the siting of the building A3.2.3 the materials of construction A3.2.4 the structural system A3.2.5 base isolation and energy absorption	Tony Gibbs
12:00-13:30	Lunch	
13:30-15:00	*A3.3 Problems Associated with Detailing and Construction* A3.3.1 ductility A3.3.2 durability A3.3.3 construction details (documentation) A3.3.4 quality assurance	Tony Gibbs
15:00-15:30	Refreshments	
	A4 Interaction	
15:30-17:00	*A4.1 Exercise* *A4.2 Tutorial* *A4.3 Questions and Answers*	All
Day 3		

(15Nov2000)		
	B1 Determination of Forces	
08:30-10:00	*B1.1 Determination of Wind Forces for Use in Analysis* B1.1.1 the fundamentals B1.1.2 using CUBiC and BNS CP28 B1.1.3 using ASCE 7-98	Tony Gibbs
10:00-10:30	Refreshments	
10:30-12:00	*B1.2 Determination of Earthquake Forces for Use in Analysis* B1.2.1 the fundamentals B1.2.2 using CUBiC B1.2.3 introduction to IBC2000	Tony Gibbs
12:00-13:30	Lunch	
	B2 Analysis	
13:30-15:00	*B2.1 Outline of Analytical Procedures- I*	Tony Gibbs
15:00-15:30	Refreshments	
15:30-17:00	*B2.2 Outline of Analytical Procedures- II*	Anthony Farrell
Day 4 (16Nov2000)		
08:30-10:00	*B2.3 Introduction to Dynamic Analysis*	Anthony Farrell
10:00-10:30	Refreshments	
10:30-12:00	*B2.4 NEHRP Analysis*	Tony Gibbs
12:00-13:30	Lunch	
	B3 Detailing	
13:30-15:00	*B3.1 Detailing for Hurricanes* B3.1.1 timber B3.1.2 masonry B3.1.3 glazing B3.1.4 roof coverings	Tony Gibbs
15:00-15:30	Refreshments	
15:30-17:00	*B3.2 Detailing for Earthquakes*	Anthony Farrell

	B3.2.1 masonry B3.2.2 concrete B3.2.3 steel	
Day 5 (17Nov2000)		
	B4 Interaction	
08:30-10:00	*B4.1 Exercise* *B4.2 Tutorial*	All
10:00-10:30	Refreshments	
10:30-12:00	*B4.3 Discussion* *B4.4 Questions and Answers*	All
12:00-13:30	Presentation of certificates and lunch	All

Multi-hazard Building Design Course

Acknowledgements

Council of Caribbean Engineering Organisations
Secretary General - Dr Clément Imbert
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Project director - Dr Jan Vermeiren
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Consulting Engineers Partnership Ltd
Document production - Mr Bernard Roach

Credits (other than those already stated on captions)

A1 Hurricane and Earthquake Hazards in the Caribbean

A1.1 The Hurricane Hazard
Figure 1 Shell Oil
Figure 3 Munich Reinsurance
Figure 6 C S Durst and William R Krayer & Richard D Marshall
Photo 1 CEP(Dominica)
Photo 2 Tony Gibbs
Photo 3 CEP(Dominica)
Photo 4 Tony Gibbs
Photo 5 CEP(Dominica)
Photo 6 Tony Gibbs
Photo 7 Tony Gibbs
Photo 8 Tony Gibbs
Photo 9 Tony Gibbs

A2 Multi-hazard Design

A2.1 Synergies and Contradictions
OHPT 1 Christopher Arnold and Robert Reitherman
OHPT 2 Christopher Arnold and Robert Reitherman
OHPT 3 SEAOC
OHPT 4 Meteorological Office, Antigua
OHPT 5 Bolton Seed
OHPT 6 Bolton Seed

OHPT 7 Finley A Charney for FEMA
OHPT 8 FEMA

A2.2 The Process of Structural Design
Figure 1 CUBiC
Figure 2 C S Durst and William R Krayer & Richard D Marshall
Figure 3 Tony Gibbs for BNS CP28

A3 Conceptual Design

A3.1 Conceptual Designs to Resist Hurricanes
OHPT 1 Tony Gibbs
OHPT 3 ODA
OHPT 4 ODA
OHPT 5 CEP(Barbados) for CDMP
OHPT 6 A G Davenport
OHPT 7 A D Adams and Tony Gibbs
OHPT 8 ODA
OHPT 9 CEP(Barbados) for United Insurance
OHPT 10 CEP(Barbados) for United Insurance

A3.2 Conceptual Designs to Resist Earthquakes
OHPT 1 Christopher Arnold and Robert Reitherman
OHPT 2 Christopher Arnold and Robert Reitherman
OHPT 3 Christopher Arnold and Robert Reitherman
OHPT 4 Christopher Arnold and Robert Reitherman
OHPT 5 Christopher Arnold and Robert Reitherman
OHPT 6 AISC
OHPT 7 Christopher Arnold and Robert Reitherman
OHPT 8 Christopher Arnold and Robert Reitherman
OHPT 9 Christopher Arnold and Robert Reitherman

A3.3 Problems Associated with Detailing and Construction
OHPT 1 Tony Gibbs photo of CEP(Dominica) project
OHPT 2 Tony Gibbs photo of CEP(Dominica) project

B1 Determination of Forces

B1.1 Determination of Wind Forces for Use in Analysis
OHPT 1 CUBiC
OHPT 2 Meteorological Office, Antigua
OHPT 3 CPACC
OHPT 4 C S Durst and William R Krayer & Richard D Marshall
OHPT 6 Tony Gibbs for BNS CP28
OHPT 7 Tony Gibbs from BOMEX
OHPT 9 NOAA
OHPT 10 University of Western Ontario, Boundary Layer Wind Tunnel Laboratory
OHPT 11 A G Davenport
OHPT 12 CUBiC

OHPT 13 BNS CP28
OHPT 14 RMS
OHPT 15 BNS CP28
OHPT 16 CUBiC

B2 Analysis

B2.1 Outline of Analytical Procedures- I

Figure 1 The Institution of Structural Engineers
Figure 2 The Institution of Structural Engineers
Figure 3 The Institution of Structural Engineers
Figure 4 The Institution of Structural Engineers

B2.2 Outline of Analytical Procedures- II

Figure 1 CEP(Trinidad)
Figure 2 CEP(Trinidad)
Figure 3 CEP(Trinidad)
Figure 4 CEP(Trinidad)
Figure 5 CEP(Trinidad)
Figure 6 CEP(Trinidad)
Figure 7 CEP(Trinidad)

B2.3 Introduction to Dynamic Analysis

Figure 1 CEP(Trinidad)
Figure 2
to
Figure 31
inclusive PowerPoint images by Finley A Charney for FEMA

B2.4 NEHRP Analysis

OHPT 4 IBC2000

B3 Detailing

B3.1 Detailing for Hurricanes

OHPT 1 Tony Gibbs
OHPT 2 CEP(Barbados) for United Insurance
OHPT 3 Anon (Australia)
OHPT 4 Anon (France)
OHPT 5 Anon
OHPT 6 Anon (France)
OHPT 7 CEP(Barbados) for BRC and United Insurance
OHPT 8 CEP(Barbados) for BRC and United Insurance
OHPT 9 CEP(Barbados) for BRC and United Insurance
OHPT 10 CEP(Barbados) for BRC and United Insurance
OHPT 11 CEP(Barbados) for BRC and United Insurance
OHPT 12 CEP(Barbados) for BRC and United Insurance
OHPT 13 CEP(Barbados) for United Insurance
OHPT 14 CEP(Barbados) for BRC

B3.2 Detailing for Earthquakes

Diagram 1	CEP(Trinidad)
Diagram 2	CEP(Trinidad)
Figure 7 to Figure 44 inclusive	S K Ghosh
Figure 45 to Figure 54 inclusive	FEMA

Abbreviations

AISC	American Institute for Steel Construction
BNS CP	Barbados National Standard Code of Practice
BRC	BRC West Indies Ltd, Barbados
CEP	Consulting Engineers Partnership Ltd
CPACC	Caribbean Planning for Adaptation to Global Climate Change
CUBiC	Caribbean Uniform Building Code
FEMA	Federal Emergency Management Agency (USA)
IBC	International Building Code (USA)
ODA	Overseas Development Administration (UK)
OHPT	Overhead projector transparency
RMS	Risk Management Solutions Inc
SEAOC	Structural Engineers Association of California