CEP

reply to
DAYRELLS ROAD
CHRIST CHURCH
BARBADOS
Tel: (246) 426 5930
Fax: (246) 426 5935
P O Box 2475, St John's, Antigua
E-Mail:tmgibbs@caribsurf.com

CONSULTING ENGINEERS PARTNERSHIP LTD

DIRECTORS.

TONY GIBBS, BSc, DCT(Leeds), FICE,FIStructE, FASCE, FConsE, FRSA
K M JOHNSON, OBE, BSc, FICE, FIWEM

Our Ref: BelizeHosp

2000-11-23

Dr Dana van Alphen
Pan American Health Organisation
Emergency Preparedness & Disaster Relief Coordination Office
Dayrells Road
Christ Church
Barbados

Dear Dr van Alphen,

Karl Heusner Memorial Hospital in Belize City

My visit to Belize on 14-17 October 2000 responded to Mr David Taylor's report on his recent visit to Belize and your request that I assist Belize(MoH) with an urgent review of the tender documents for the European Union Rehabilitation Project and a less-pressing vulnerability assessment of the critical areas of the Hospital.

This letter serves to summarise the main issues identified during my visit.

I reviewed the drawings and technical specifications for the eleven tender packages for the EU project. The main areas in the documents requiring attention are:

1 the absence of longitudinal slopes for roof drainage;
2 the lack of wind-resistant specifications for the base coat and membrane waterproofing;
3 the lack of fixing details for hurricane shutters;
4 the lack of wind-and-impact-resistant criteria for accordion shutters, Bahama shutters and removable aluminium storm panels;
5 the use of gravel in courtyards and enclosures;
6 the detailing of very tight bends for high-strength reinforcing bars;

7 the reliance on tenderers for determining the nature of the ground to be excavated;
8 the absence of horizontal reinforcement in block walls;

9 the absence of positive restraints for the blockwalls along their top borders;
10 the general lack of specifications for the anchorages of equipment and services against earthquake forces;
11 the absence of flexibility where pipes and ducts cross movement joints in the Hospital and exit the Hospital;
12 the lack of wind-resistant specifications for sheet-metal coverings for electrical cables.

All of the above issues were discussed with the local consultants, Burrell & Burrell, and project coordinators, Studio Bichara (Savvidou), at a meeting also attended by PAHO (Amalia del Riego) and the Ministry of Health (Courtenay). B&B and SB were encouraged to address all of these matters through negotiation with the selected contractors before the award of contracts.

The above-mentioned meeting started with a discussion on the design standards for hurricanes (winds and surge). The stated intention of B&B and SB, presumably in consultation with the MoH, is to design for a Category-2 hurricane (1-minute wind speeds of 96 to 110 mph, surge in the USA of 6 to 7 feet, pressure 965 to 980 mb). The main reason for this is the impracticality of counteracting the storm surge from more severe events. I pointed out that 50% (or more) of the hurricanes striking Belize City would produce no (or negative) surge. Therefore it is worthwhile providing higher levels of protection (in accordance with the proposed Belize Building Code or CUBiC) for roofs, windows, external doors, cladding and external appurtenances.

Concern was expressed about the lack of reliable information on the existing external block walls - how were they reinforced and how they were tied in to the adjacent columns and beams. These matters have a major effect on the vulnerability of the building envelope. This must be investigated.

The significant problem of leaking through walls and window assemblages was discussed. This critical issue may need to be addressed with assistance from a specialist firm such as Glazing Consultants Inc of Florida.

During my stay in Belize I initiated the vulnerability assessment of the critical areas of the hospital. So-called "as-built" drawings were reviewed and a selection copied for further study. It is intended that I return to Belize in the near future (under a different contract) to finish the field work required for the vulnerability assessment.

Debriefing meetings were held with Permanent Secretary Anderson and PAHO Representative Dr Graciela Uriburu. Mr Anderson indicated the possibility of obtaining additional funds for improving the mitigation aspects of the EU Rehabilitation project. Dr Uriburu supported the course of action proposed by me.

Throughout my visit I received the considerable cooperation of the PAHO officers (Dr Amalia del Riego in particular) and the Ministry's architect Sue Courtenay.

The EU project is amenable to improvement. I indicated to the local consultants that assistance in determining the appropriate wind and earthquake forces for the specifications could be provided through my contract with PAHO. There is time to make the adjustments.

The Notes on my visit to Belize are attached as Appendices I-VI. These Notes include specific recommendations (in outline) for reducing the vulnerability of the Hospital during the implementation of the European Union Rehabilitation Project. In addition, 30 captioned photographs are included in this Report.

Yours sincerely

Tony Gibbs

b Structural calculations
One volume

c Technical Specifications
One volume

These were reviewed and those documents relevant for the vulnerability assessment of critical facilities were copied by PAHO for TG to take to Barbados for further study.

It has to be said that the documentation of the structural works was very disappointing on two counts:

d There are no drawings showing the overall structural concept;

e The drawings and specifications do not bear a strong resemblance to the built facility.

II Site Visit on Sunday 15 October 2000

0 Present: Mrs Sue Courtenay, Architect, MoH Planning Unit
Tony Gibbs, CEP

1 The purposes were:
a to see all of the areas which are the subject of the European Union Rehabilitation Project;
b to see all of the areas identified by David Taylor (PAHO-bgi) as being critical to the functioning of the Hospital.

2 All of the above areas, with the sole exception of the roof, were visited. (The roof was visited after the technical meeting of 16 October.)

3 Photographs illustrating several of the observations are attached at the end of these Notes.

4 There was much evidence that the drawings of the original construction were not as-built drawings *eg* roof covering, suspended slabs, column shapes, the location and plan geometry of the Utilities block all differ from drawings to construction.

5 One could not help but be saddened by the location and design of the hospital and its condition after 5 years of use. No visitor, without being told, could have guessed that this was a hospital designed and constructed in the 1990s.

6 In general the following were noted:

a staircases with dangerous geometries (Photo 18);
b shelving and cupboards with no regard for the earthquake hazard (Photos 13-15);
c furniture with no regard for the earthquake hazard (Photos 15&16);
d leaks everywhere (through roofs, walls, window frames, pipes, ducts);
e cracks everywhere;
f loose tiles everywhere;
g pealing paint;
h damaged ceilings (Photo 11);
i loose light fixtures (Photo 12);
j equipment not anchored (Photo 30);
k water lodged between waterproof membrane and roof slab of the Utilities Block (Photo 27) and elsewhere (Photo 7);
l *etc, etc, etc.*

III Questions and Comments and Recommendations

(based on a review of the EU Rehabilitation Project technical documents by Tony Gibbs)

Morning of 16 October 2000

Responses, other information and comments made at the technical meeting (13:30, 16 October 2000) are in italics.

#1 Roofing and Waterproofing

1 Sheets 4&5 - 2% slopes are OK. What are the slopes in the longitudinal direction?
None at present. B&B agreed to reshape the roof surface to achieve falls everywhere with minimum slopes of 2% average from furthest points to drain inlets.

2 Sheet 6 - What is the wind resistance of base coat and membrane?
None stated. B&B agreed to negotiate appropriate wind uplift forces with selected contractor before contract award. TG offered to assist, if necessary, with the determination of forces through his contract with PAHO.

3 No technical specification document has been provided.
B&B agreed to provide this to TG. It does not contain wind design criteria.

#2 Hurricane Shutters

1 Sheet 48 - No fixing details
B&B were asked to show these on their drawings or to require contractors to submit them in shop drawings for approval by B&B.

2 Sheet 49 - No fixing details
B&B were asked to show these on their drawings or to require contractors to submit them in shop drawings for approval by B&B.

3 TechSpec - No design criteria (wind and impact) for accordion, Bahama shutters and removable aluminium storm panel. Roll-up shutters to "comply with the South Florida Building Code, 1994" and mention is made of storm bars for long spans.
It is recommended that B&B negotiate with selected contractor to provide shutters with the appropriate wind and impact resistance criteria. TG offered to assist, if necessary, with the determination of forces through his contract with PAHO.

#3 Courtyards and Enclosures

1 Sheet 5 - Gravel poses a small problem in this open courtyard if windows are not provided with shutters.
Accepted

#4 Technical Building

1 I understand that the height of the surge barrier wall is determined on the basis of a Category 3 hurricane. The irony is that the greater the (post-hazard-event) need for a facility such as the KHM Hospital the less likely it is to be operational.
No, Category 2 (upper limit) is the basis for design.

2 What datum are the levels on drawings (*eg* Sheet 7) related to?
Mean sea level. ie the ground level adjacent to the Utilities Block is 1.23m above msl

3 Sheet 8 - What grade of steel is intended? 0.5-inch diameter bend for 0.625-inch diameter bar!
The bar will crack in bending. Diameter of bends should be amended.

4 TechSpec - Clause 2.1 "The Contractor must satisfy himself as to the nature of the ground to be excavated." is unfair and could lead to increased tender prices.

5 TechSpec - Clause 3.9 answers Q#4-3

6 TechSpec - Clause 4.1 does not call for horizontal reinforcement. Vertical and horizontal reinforcement should be placed in all walls.
This is a requirement for safety in earthquakes (all walls) and in hurricanes (external walls).

#5 Repairs to External Walls

1 Sheet 3 - What reinforcement is there in the existing external block walls? How are the walls tied in to the columns and beams?
These are not known. There is a suspicion that the reinforcement is not present.

2 From the crack patterns, there is not much evidence of differential settlement (Photo 20).
Differential settlement usually produces diagonal cracking.

3 Sheet 9 - 0.0254m is not the recommended way to write a dimension. What is an EPS panel? Can expansive foam transmit shear?
EPS = expanded polystyrene. Expansive foam cannot transmit shear.

4 The significant problem of leaking through walls and window assemblages may need to be addressed with assistance from a specialist firm such as Glazing Consultants Inc of Florida.
TG does not know the cost of specialist testing. It could be of the order of US$20,000. If required, TG could provide GCI's coordinates.

5 Sheet 10 - The sections do not show the giprock drywall on the inside. Are the walls 8" or 6"?
8 inch

6 TechSpec - Are clauses 2.1 to 2.13 really appropriate for the contract? If not, how is the contractor to know which clauses to take seriously and which to ignore? The Technical Specifications should relate to the particular contract.
TG recommended that irrelevant clauses be removed from technical specifications.

#6 Air Conditioning

1 TechSpec - in Clause 4.3 what are Armaflex supports? Are they capable of resisting earthquake forces?
Armaflex is a brand name. Earthquake forces have not been considered. TG recommended that pipe runs be reviewed to see whether anticipated horizontal displacements could endanger the system.

2 Do any of the pipes cross expansion or separation joints? Can the crossings accommodate relative movements?
There are supposed to be 3 expansion joints in the building. Dimitra has been able to locate only one of them. TG noted that the "as-built" drawings showed several instances of expansion joint details over-stamped "ANULADO"
B&B agreed to review situations where pipes and ducts crossed expansion joints.

3 TechSpec - in Clause 6.4 brackets should be checked for earthquake forces (horizontal and vertical).

B&B should do this.

4 There is no mention of anchoring AC units for earthquakes (all situations) and hurricanes (external only).
B&B should review this.

5 TechSpec - in Clause 19.1 as-built drawings are the contractor's responsibility. For some other aspects of the various contracts the responsibility is (should be) the consultant's. For both contractors and consultant final payments should be contingent on the client's receipt of as-built drawings.
B&B are well aware of this matter. Provisions are in place to provide the client with a complete set of as-built documentation.

#7 Boiler Works

1 No drawings were provided.

2 TechSpec - Clause 11.1 states "....support properly all pipework." The contractor needs to be told what the supports are to achieve, including earthquake resistance.
Alternatively B&B could prescribe the support details.

3 The opportunity should be taken to check the anchorages of all equipment (Photo 30).
Noted by B&B.

#8 Drainage Works

1 Do any of the pipes cross expansion or separation joints? Can the crossings accommodate relative movements?
See #6-2.

2 Sheet 4 - Is the absence of horizontal restraint a potential problem in any area?
See #6-1.

3 Where pipes enter the ground from the building there should be a detail provided to accommodate differential movement?
B&B to review.

4 TechSpec - Clause 2.1 states "All the sewerage drainage pipework below the building is to be replaced with new supports." The contractor needs to be told what the supports are to achieve, including earthquake resistance.
See #7-2.

5 TechSpec - Clauses 3.1 and 4.1 describe fixings and pipe supports. Do these items

address the issue of restrains in earthquakes?
No. See #7-2.

#9 Electrical Works

1 No drawings provided

2 TechSpec - Clause 8.1 describes sheet metal coverings. The existing coverings were damaged by a tropical storm (Keith in Belize City) (Photos 23&24). The new coverings should be resistant to the appropriate level of hurricane hazard.
B&B should provide either fixing details or performance criteria.

3 TechSpec - Clause 10.6 states "If suspended lights are changed they are to be re-hung and supported properly....." The contractor needs to be told what the supports are to achieve, including earthquake resistance (Photo 12).
See #9-2.

4 The opportunity should be taken to check the anchorages of all equipment.
Noted.

#10 Fire Alarm

1 No drawings provided

2 If there is any heavy equipment or panels or cabinets, they should be anchored to resist the prescribed earthquake standards.
Noted.

#11 Plumbing Works, Water Distribution System

1 Sheet 4 - Details of fixings should be given, or the performance standards (for natural hazards) should be stated.
See #9-2.

2 Wherever pipes may enter the ground from the facility there should be details provided to accommodate differential movement.
See #8-3

3 Sheet 7 - The ladder to the roof of the Mechanical-Technical Building, also, should be replaced or adjusted. (The third rung from the roof is missing. -- Photo 26)

4 TechSpec - Clause 8.1 states "The hot water pipework where it is sagging under the building is to be resupported at 700mm intervals." Does this provide for earthquake

resistance?
See #8-5.

5 The opportunity should be taken to check the anchorages of all equipment.
Noted.

IV Meeting with Burrell & Burrell and Studio Bichara

13:30 Monday 16 October 2000

0 Present: Cuthbert D A Burrell, B&B
Paul E Satchwell, B&B
Dimitra Savvidou, SB
Dr Amalia del Riego, Health Policy & Systems Development, PAHO
Mrs Sue Courtenay, MoH Architect
Tony Gibbs, CEP

1 Studio Bichara is under contract to the EU to coordinate the project, including the supervision of the local consultants. Dimitra represents SB in Belize.

2 B&B is under contract to the MoH to design and inspect the works.

3 Sue Courtenay is the technical representative for the MoH on the project.

4 The hospital (115 beds) is in surprisingly poor condition after only 5 years in use. It is a long story.

5 The meeting started with a discussion on the design standards for hurricanes (winds and surge).

The stated intention of B&B and SB, presumably in consultation with the MoH, is to design for a Category 2 hurricane (1-minute wind speeds of 96 to 110 mph, surge in the USA of 6 to 7 feet, pressure 965 to 980 mb). The main reason for this is the impracticality of counteracting the storm surge from more severe events.

TG pointed out that 50% (or more) of the hurricanes striking Belize City would produce no (or negative) surge. Therefore it is worthwhile providing higher levels of protection (in accordance with the proposed Belize Building Code or CUBiC) for roofs, windows, external doors, cladding and external appurtenances.

V Meeting with Permanent Secretary Henry Anderson

16:30 Monday 16 October 2000

0 Present: Mr H Anderson, PS-MoH
Dr Amalia del Riego, Health Policy & Systems Development, PAHO
Mrs Sue Courtenay, MoH Architect
Tony Gibbs, CEP

1 TG outlined his Terms of Reference:
- a Review of EU Rehabilitation Project
- b Vulnerability survey of critical areas of the hospital

2 TG presented a summary of the technical meeting with B&B and SB:
- a Need to specify performance standards for wind and flying debris for shutters
- b Need to specify performance standards for wind for roof waterproofing
- c Need to specify performance standards for earthquakes for restraints of pipes and ducts
- d Need to specify performance standards for earthquakes (all situations) and wind (external items) for anchorage of equipment
- e Desirability of testing prototype of repaired wall panel for effectiveness of procedures for dealing with the leaking problem
  Specialist consultant (eg GCI) should be involved for the testing.
- f Concern about the stability of external in-fill walls which may not be reinforced and which may not be tied into adjacent columns and beams (Photo 20)
- g B&B and SB appear to be willing to amend the specifications to address the above problems but they are conscious of budget limitations.

3 It is important that repairs be done well so as to deal effectively with existing problems. The most expensive building is the one that fails.

The PS indicated that additional funding (from IDB) could be made available but cash flow could be a constraint.

VI Debriefing with Dr Graciela Uriburu

18:00 Monday 16 October 2000

0 Present: Dr Graciela Uriburu, Representative, PAHO
Dr Amalia del Riego, PAHO
Tony Gibbs, CEP

1 The visit was summarised under the following headings:

- a Site visit of Sunday 15 October
- b Study of documents of the EU Rehab Project
- c Review of "as-built" documents for original hospital construction

d Meeting with B&B and SB
e Meeting with PS-MoH

2 Dr Uriburu considered it important to involve Marcel van Opstal, EU Rep in Belize, in the mitigation proposals.

3 TG explained that his ToR required only a summary report dealing with urgent issues (the EU Rehab Project) to be issued by the end of this week. The final and fuller report for this assignment was to be issued by the end of November. This is because of TG's previous commitments ending 18 November 2000.

4 Dr Uriburu requested that a 2-page summary letter, suitable for PAHO to issue to the PS and the EU Rep, be written very soon. The notes of the visit could be attached as an appendix.

5 The second stage of TG's assignment (not covered by the present contract) is tentatively scheduled for early December 2000.

6 Dr Uriburu arranged with John Flowers (PAHO, home 70063) for TG to be taken to the airport on 17 October. [The road to the airport is in very bad shape with large holes and flooding (Photos 1&2). Conventional taxis could have difficulty (Photo 3). This was evident when Emerson James (Grenadian grandparents) of PAHO had taken TG from airport to hotel on 14 October.]