PIM Earthquake Damage Assessment and Reconstruction Report

Haiti

March 2010

Investment Climate Department

With funding from FIAS, the multi-donor investment climate advisory service
About the Investment Climate Department of the World Bank Group (IC)

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The findings, interpretations and conclusions included in this note are those of the author and do not necessarily reflect the view of the Executive Directors of the World Bank Group or the governments they represent.
**Table of Contents**

1. Summary ...................................................................................................................................... 4
2. Background & Scope .................................................................................................................. 5
3. Description of Damage Evaluation Procedures ........................................................................ 6
4. Damage Assessment of PIM Industrial Buildings .................................................................... 7
5. Construction Companies and Earthquake-Resistant Materials Required for Reconstructing Factory Shells .................................................................................................................................. 13
6. Cost Estimates to Reconstruct PIM Factory Shells .................................................................. 14
1. Summary

Following the devastating magnitude 7.0 Mw earthquake in Haiti, IC conducted a first stage evaluation for the garment factories at the Parc Industriel Metropolitain (PIM) (also known as SONAPI) and a site visit to the main port of Haiti (15-19 Feb. 2010).

For PIM the overall performance was acceptable. There were no collapsed structures and preliminary conclusions suggest that only (1) one factory shell should be demolished, (10) ten factory shells would require mayor repair and the remaining (35) thirty five buildings will require minor repairs. Three (3) factories were not inspected because two were occupied by the UN and one was closed and the owner did not grant access. According to this quick assessment, the total estimated cost of repair/rebuilding these shells to earthquake-resistant standards would be around US$ 20.7 (average of US$ 415,418 per shell).

In addition to the PIM factories, the team inspected the main port of Haiti and the road leading to the port. The port infrastructure, both at north and south piers, was heavily damaged, unusable, thus requiring a major reconstruction. Part of the dock discharge area sunk and its two cranes are damaged. The buildings holding containers are about to collapse. The operators are using some alternative options, including two moving barges rented from Crowley Maritime, a US firm, that have been used as temporary docks for cargo. Crowley Maritime was also working to clear the fallen cranes from the port in addition to removing other debris and help increase the flow of goods in and out of Haiti. In general the port infrastructure was heavily damaged. Part of the discharge area sunk, the (2) two cranes that used to operate are damaged and the buildings designated for container storage are on the verge of collapse. Currently, the port is using alternative options to operate, including two moving barges rented from a US firm. The road was not heavily damaged and firms encountered minimal disruption in transporting their goods to the port. The road was heavily congested due to increased traffic caused by the relief operators.

None of the buildings or structures other than the port had any architectural or structural drawings or information that could give an idea of their structural system. Therefore, the next step for any evaluation and/or more detailed cost estimates should be to measure and produce "as built" engineering/architectural drawings.

Recommendation:
PIM does not only need to rebuild the damaged structures, the park should expand if it is to solve one of the most important bottlenecks in Haiti for the garment sector expansion/job creation in the short term: lack of serviced land. It would be a missed opportunity to seek funding and budget for the reconstruction of PIM only. PIM does not only to rebuild existing shells but build more of them.

The IC team undertook in Oct. 09 a pre-feasibility report for the expansion of PIM to include 19 additional shells, which could involve the creation of 9,000 jobs for the Port-au-Prince region in direct employment. The cost of the expansion (Phase I, II and III) was estimated at $24,5m. In December 2009 the Inter-American Development Bank (IDB) committed $4m to undertaking Phase I of the PIM expansion. Needless to say that these additional shells in PIM would be oversubscribed by existing tenants of based on current expressions of interest of garment companies.
According to both pre-feasibility reports undertaken by IC the cost of reconstruction and expansion work of PIM would be $45.2m to take advantage of the current catastrophic situation as an opportunity to improve private sector development and job creation in the short term.

2. Background & Scope

A magnitude 7.0 Mw earthquake struck Haiti on January 12, 2010 at 21:53 UTC, approximately 25 km (16 mi) WSW from Port-au-Prince at a depth of 13 km (8.1 mi) on the Enriquillo-Plantain Garden fault system according to the USGS data. Strong shaking was associated with intensity IX on the Modified Mercalli scale (MM), a range that can cause moderate to very heavy damage even to earthquake-resistant structures.

The quake occurred at the boundary of the Caribbean plate and North American plate, which accommodates 20 millimeters (0.79 in) per year. The strike-slip fault system in the region has two branches in Haiti, the Septentrional-Orient fault in the north and the Enriquillo-Plantain Garden fault in the south which accommodates about 7 millimeters per year. Both its location and focal mechanism suggest that the January 2010 quake was caused by a rupture of the Enriquillo-Plantain Garden fault, which had been locked for 250 years, gathering stress, since last quake on April 8th 1760.

The island where Haiti is located is on a high seismicity risk area. For this reason a comprehensive assessment of existing buildings should be evaluated and, if needed, reinforced so that Haiti is ready for future seismic activity.

The objective of this piece of work is to conduct a rapid technical assessment of the reconstruction requirements and costs for PIM and the logistics infrastructure in Port-au-Prince. The four-day mission to Haiti focused on visiting 49 buildings housing garment operations inside PIM, performing a visual inspection and seeking architectural or structural drawings in order to estimate the seriousness of damage and estimate repair/rebuilding costs of such industrial buildings. No assessment was done of damaged machinery or equipments, lost sales, opportunity cost of workers being used for non-productive tasks, or any other losses that occur under such a natural disaster. Cost of demolition will need to be added where relevant.

This report presents an evaluation of the damages and repair/reconstruction recommendations by building, suggests materials needed, identifies vendors and availability in the country, and estimates overall cost for the repair/reconstruction of PIM, taking into account more earthquake-resistant structures.
3. Description of Damage Evaluation Procedures

The damage evaluation procedures seek to identify the damage caused by January 12th earthquake and understand future building performance in case another earthquake hits Port au Prince. The specific objectives of this investigation were to:

a) Gather information on the characteristics of the damaging ground motion at the building site;
b) Verify the general physical characteristics of the building;
c) Identify structural components and elements of the lateral-force-resisting system;
d) Determine structural properties of the components in sufficient detail;
e) Observe and record damage to the components;
f) Distinguish, to the extent possible, between damage caused by the earthquake and damage that may have existed prior to the earthquake.

The evaluation followed the methodology of FEMA 306 ("Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings")¹ and surveyed the structures within PIM. Methods for inspecting and testing concrete and masonry wall buildings for earthquake damage fall into two general categories: non-destructive and intrusive. The methodology applied for this assessment used a non-destructive inspection procedures, especially using visual observation of all elements and components of lateral-load-resisting systems to detect crack location and size, spall location and size, reinforcing if found (location and buckling), as well as element thickness. All damaged sites and buildings were photographed for further reference and analysis. The consultant also requested architectural or structural drawings, but none were available.

For the reasons above the consultant urges additional evaluation to the shells, including measurement, drafting of "as built" engineering/architectural drawings, and analysis of the assembly of each individual component of the buildings. This would shed light not only on building safety, but also on the main causes of damage to the structures, and may reveal component behavior that differs from that predicted by this evaluation. By determining how structural properties changed, performance restoration actions could be formulated to restore the damaged buildings to earthquake safe standards. This would also provide the foundation for a more detailed repair/reconstruction cost estimate per building.

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4. Damage Assessment of PIM Industrial Buildings

Figure 1 provides a master plan of the PIM area. The buildings were visually inspected internally and externally.

**Figure 1**

Source: SONAPI
There are four structural systems which are explained in table 1. Each structure responded differently to the seismic activity and in accordance with the type of soils and foundations.

**Table 1: Structural Systems**

<table>
<thead>
<tr>
<th>Type</th>
<th>Structural Systems</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Str-1</td>
<td>Steel frame with variable section on columns and beams, supported on concrete column bases. Ceiling is steel deck roofing, non-rigid diaphragm. The enclosing walls are not connected to the main structure.</td>
<td><img src="image1.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Str-2</td>
<td>Concrete variable section columns with enclosing unreinforced masonry restraining the displacements. Ceiling is steel deck roofing supported on steel trusses, non-rigid diaphragm.</td>
<td><img src="image2.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Str-3</td>
<td>Steel frame with variable section on columns and beams, supported on concrete columns bases, the enclosing walls are connected to the main structure. Ceiling is steel deck roofing, non-rigid diaphragm.</td>
<td><img src="image3.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Str-4</td>
<td>Concrete Moment Resisting Frame with concrete slabs on the first floor and steel deck on the roof (Second floor). The enclosing walls are unreinforced masonry restraining the displacements. It was evident the captive columns all over the perimeter of structure.</td>
<td><img src="image4.jpg" alt="Image" /></td>
</tr>
</tbody>
</table>

While no clear conclusions can be drawn from this exercise, preliminary findings suggest that the resilience of the structures to seismic activities were as follows (in order from strongest to weakest): Str-1, Str-3, Str-2, and Str-4.

Table 2 summarizes the damages found in each building inspected inside PIM.

**Table 2: Report of Damages**

<table>
<thead>
<tr>
<th>Nº</th>
<th>BUILDING (B)</th>
<th>STRUCTURAL SYSTEM</th>
<th>DAMAGE</th>
<th>CONDITION</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B1_UN</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>B2_CLOSE_UN</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>B3</td>
<td>Str-3</td>
<td>Closing walls:moderate</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>Nº</td>
<td>BUILDING</td>
<td>STRUCTURAL SYSTEM</td>
<td>DAMAGE</td>
<td>CONDITION</td>
<td>RECOMMENDATIONS</td>
</tr>
<tr>
<td>----</td>
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</tr>
</tbody>
</table>
| 4  | B4       | Str-2            | Closing walls have heavy damage, plastic hinge at base of all columns. Steel truss concrete column connection. Office structural walls heavily damage and roof also. | Not-Usable | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 5  | B5       | Str-2            | Closing walls have heavy damage, plastic hinge at base of most columns. Steel truss concrete column connection. Office structural walls damage. | Not-Usable | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 6  | B6       | Str-2            | Closing walls have heavy damage, plastic hinge at base of most columns. Steel truss concrete column connection. Office structural walls minimum damage. | Not-Usable | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 7  | B7       | Str-2            | Closing walls have heavy damage, plastic hinge at base of most columns. Steel truss concrete column connection. Office structural walls heavily damage. | Not-Usable | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 8  | B8       | Str-2            | Closing walls have heavy damage, plastic hinge at base of most columns. Steel truss concrete column connection. Office structural walls heavily damage. | Not-Usable | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 9  | B9_SONAPI | Str-4            | Closing walls; moderate, some beams and columns | Usable    | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 10 | B10      | Str-2            | Closing walls have heavy damage, plastic hinge at base of most columns. Steel truss concrete column connection. Office structural walls heavily damage. | Not-Usable | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 11 | B11      | Str-1            | Closing walls have moderate damage, plastic hinge at base of most columns. Office structural walls damage. | Usable    | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 12 | B12      | Str-1            | Closing walls have heavy damage, plastic hinge at base of most columns. Office structural walls damage. | Usable    | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
    |          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
| 13 | B13      | Str-1            | Closing walls have heavy damage, plastic hinge at base of most columns. | Usable    | a)-Replace/Dry-pack damage units.  
    |          |                  |         |           | b)-Reappoint spalled mortar and open head joints.  
    |          |                  |         |           | c)-Inject cracks and open head joints.  
<pre><code>|          |                  |         |           | d)-Install pins and drilled dowels in toe regions. |
</code></pre>
<p>| 14 | B14_UN   | N/A              | N/A    | N/A       | N/A            |</p>
<table>
<thead>
<tr>
<th>Nº</th>
<th>BUILDING (B)</th>
<th>STRUCTURAL SYSTEM</th>
<th>DAMAGE</th>
<th>CONDITION</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
</table>
| 15 | B15          | Str-2            | Closing walls have heavy damage, plastic hinge at base of all columns. Steel truss concrete column connection. Office structural walls heavily damage. | Not-Usable | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 16 | B16          | Str-2            | Closing walls have heavy damage, plastic hinge at base of most columns. Steel truss concrete column connection. Office structural walls damage. | Usable     | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 17 | B17          | Str-2            | Closing walls have heavy damage, plastic hinge at base of most columns. Steel truss concrete column connection. Office structural walls damage. | Usable     | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 18 | B18          | Str-2            | Closing walls have heavy damage, plastic hinge at base of most columns. Steel truss concrete column connection. Office structural walls damage. | Not-Usable | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 19 | B19          | Str-3            | Closing walls have heavy damage, plastic hinge at base of most columns. | Not-Usable | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 20 | B20          | Str-2            | Closing walls have heavy damage, plastic hinge at base of all columns. Steel truss concrete column connection. | Not-Usable | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 21 | B21          | Str-1            | Closing walls have moderate damage, plastic hinge at base of most columns. | Usable     | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 22 | B22          | Str-4            | All columns and beams developed plastic hinge at different locations. No shear walls found. | Not-Usable | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 23 | B23          | Str-1            | Closing walls have moderate damage, plastic hinge at base of most columns. Office structural walls damage. | Usable     | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 24 | B24          | Str-1            | Closing walls have moderate damage, plastic hinge at base of most columns. Office structural walls damage. | Usable     | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 25 | B25          | Str-1            | Closing walls have moderate damage, plastic hinge at base of most columns. | Usable     | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 26 | B26          | Str-1            | Closing walls have minimum damage. | Usable     | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints. |
<table>
<thead>
<tr>
<th>Nº</th>
<th>BUILDING (B)</th>
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<th>DAMAGE</th>
<th>CONDITION</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
</table>
| 27 | B27          | Str-1             | Closing walls have moderate damage, plastic hinge at base of most columns. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 28 | B28          | Str-1             | Closing walls have moderate damage, plastic hinge at base of most columns. Main entrance should be rebuilt completely. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 29 | B29          | Str-1             | Closing walls have moderate damage, plastic hinge at base of most columns. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 30 | B30          | Str-1             | Closing walls have heavy damage, plastic hinge at base of most columns. Office structural walls damage. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 31 | B31          | Str-1             | Closing walls have moderate damage, plastic hinge at base of most columns. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 32 | B32          | Str-1             | Closing walls have moderate damage, plastic hinge at base of most columns. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 33 | B33          | Str-1             | Closing walls have heavy damage, plastic hinge at base of most columns. Office structural walls, beams and columns damage. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 34 | B34          | Str-1             | Closing walls have moderate damage, plastic hinge at base of most columns. Office structural walls damage. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 35 | B35          | Str-1             | Closing walls have moderate damage, plastic hinge at base of most columns. Office structural walls damage. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
| 36 | B36          | Str-1             | Closing walls have moderate damage, plastic hinge at base of most columns. | Usable  | a)-Replace/Dry-pack damage units.  
b)-Reappoint spalled mortar and open head joints.  
c)-Inject cracks and open head joints.  
d)-Install pins and drilled dowels in toe regions. |
<table>
<thead>
<tr>
<th>Nº</th>
<th>BUILDING (B)</th>
<th>STRUCTURAL SYSTEM</th>
<th>DAMAGE</th>
<th>CONDITION</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>B37</td>
<td>Str-1</td>
<td>Back closing wall has severe damage. Also an adjacent structure on the left had some problems. Plastic hinge at base of some columns.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>38</td>
<td>B38</td>
<td>Str-1</td>
<td>Back closing wall has severe damage and some on lateral. Plastic hinge at base of some columns. Office walls have moderate to heavy damage.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>39</td>
<td>B39</td>
<td>Str-1</td>
<td>Back closing wall has severe damage and some on lateral walls. Plastic hinge at base of some columns.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>40</td>
<td>B40</td>
<td>Str-1</td>
<td>Back closing wall has severe damage and some on lateral walls. Plastic hinge at base of some columns.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>41</td>
<td>B41</td>
<td>Str-1</td>
<td>Closing walls have moderate damage. Plastic hinge at base of some columns. Office got some construction joint cracks.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>42</td>
<td>B42</td>
<td>Str-1</td>
<td>Closing walls have moderate damage. Plastic hinge at base of some columns. Office got some construction joint cracks.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>43</td>
<td>B43</td>
<td>Str-1</td>
<td>Closing walls have moderate to heavy damage. Plastic hinge at base of some columns.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>44</td>
<td>B44</td>
<td>Str-1</td>
<td>Closing walls have moderate to heavy damage. Plastic hinge at base of some columns.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints. d)-Install pins and drilled dowels in toe regions.</td>
</tr>
<tr>
<td>45</td>
<td>B45</td>
<td>Str-1</td>
<td>Closing walls have minimum damage.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints. c)-Inject cracks and open head joints.</td>
</tr>
<tr>
<td>46</td>
<td>B46</td>
<td>Str-1</td>
<td>Closing walls and office have minimum damage.</td>
<td>Usable</td>
<td>a)-Replace/Dry-pack damage units. b)-Reappoint spalled mortar and open head joints.</td>
</tr>
</tbody>
</table>
### BUILDING (B) STRUCTURAL SYSTEM DAMAGE CONDITION RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Nº</th>
<th>BUILDING (B)</th>
<th>STRUCTURAL SYSTEM</th>
<th>DAMAGE</th>
<th>CONDITION</th>
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</thead>
</table>
| 47 | B47          | Str-1             | Closing walls and office have minimum damage. | Usable | a) Replace/Dry-pack damage units.  
|    |              |                   |        |           | b) Reappoint spalled mortar and open head joints.  
|    |              |                   |        |           | c) Inject cracks and open head joints. |
| 48 | B48          | Str-1             | Closing walls have minimum damage. | Usable | a) Replace/Dry-pack damage units.  
|    |              |                   |        |           | b) Reappoint spalled mortar and open head joints.  
|    |              |                   |        |           | c) Inject cracks and open head joints. |
| 49 | B49          | Str-1             | Closing walls and office have moderate damage, plastic hinge at base of most columns. | Usable | a) Replace/Dry-pack damage units.  
|    |              |                   |        |           | b) Reappoint spalled mortar and open head joints.  
|    |              |                   |        |           | c) Inject cracks and open head joints.  
|    |              |                   |        |           | d) Install pins and drilled dowels in toe regions. |

According to the inspection, the findings suggest that for PIM:

- 35 buildings (71.4%) are *usable*
- 10 buildings (20.5%) are *not usable and need major repair*
- 1 factory shell (2.0%) *should be demolished*
- 3 buildings (6.1%) were *not inspected* because Buildings 1 and 2 were occupied by the United Nations, and access was not granted to Building 14.

### 5. Construction Companies and Earthquake-Resistant Materials Required for Reconstructing Factory Shells

The engineering mission confirmed that there are construction companies, both Haitian and foreign, capable of successfully completing the PIM reconstruction according to regional earthquake-proof standards. The firms indicated that they were available to provide repair services immediately².

Earthquake-resistant construction materials such as concrete, blocks and steel reinforcing bars are also available in Haiti, but materials like steel (rolled shapes and roof decks), grout for injections, and epoxy need to be imported, and if available in Haiti, supply is very limited.

Special attention should be put on the quality of concrete blocks. The inspections revealed that builders had used very poor quality concrete blocks. It is therefore strongly recommended to verify quality with the supplier. Table 3 shows materials required to repair the factories, their prices and availability in Haiti and possible suppliers.

---

² This list is by no means comprehensive of all construction companies available, and should be used as an indication only.
Table 3: Availability of Materials Required to Reconstructing Factory Shells in Haiti

<table>
<thead>
<tr>
<th>Material</th>
<th>Price (Gourde)</th>
<th>Measure</th>
<th>Availability in Haiti</th>
<th>Supplier Contacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>290.00</td>
<td>Bags</td>
<td>YES</td>
<td>Cement Nationale, Cemex</td>
</tr>
<tr>
<td>Ready Mix Concrete</td>
<td>331.00</td>
<td>m3</td>
<td>YES</td>
<td>GDG Betron, Betonex</td>
</tr>
<tr>
<td>Concrete Blocks (Masonry Units)</td>
<td>34.00</td>
<td>Units</td>
<td>YES</td>
<td>Block D'Haiti</td>
</tr>
<tr>
<td>Reinforcing bars</td>
<td>40,000.00</td>
<td>Ton.</td>
<td>YES</td>
<td>Acierie D'Haiti</td>
</tr>
<tr>
<td>Steel, grout, epoxy</td>
<td>N/A</td>
<td>Ton./m3</td>
<td>NO</td>
<td>Imported</td>
</tr>
</tbody>
</table>

6. Cost Estimates to Reconstruct Factory Shells

The evaluation was based on a rapid visual screening of forty nine (49) structures in PIM. Therefore, only rough estimates of structural repairs costs are provided. These estimates are based on engineering judgment as well as on the cost estimates from previous work for the SONAPI buildings. Estimated costs per factory are based on the standard 30mx70m size factory shells found inside PIM (with the exception of building #22 which is a two story building). The cost estimates are based on reconstruction of buildings to regional earthquake safe standards. The rough estimates to reconstruct are shown in table 4.

Table 4: Damage-cost estimates - PIM

<table>
<thead>
<tr>
<th>Nº</th>
<th>BUILDING</th>
<th>PERCENTAGE DAMAGE ESTIMATE (%)</th>
<th>COST ESTIMATE (USD $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B1_UN</td>
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</tr>
<tr>
<td>2</td>
<td>B2_CLOSE_UN_AREA</td>
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<td>3</td>
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<td>4</td>
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<td>B5</td>
<td>40</td>
<td>521,304.00</td>
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<tr>
<td>6</td>
<td>B6</td>
<td>45</td>
<td>586,467.00</td>
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<tr>
<td>7</td>
<td>B7</td>
<td>60</td>
<td>781,955.00</td>
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<tr>
<td>8</td>
<td>B8</td>
<td>60</td>
<td>781,955.00</td>
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<td>9</td>
<td>B9_SONAPI</td>
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<td>B11</td>
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<td>BUILDING</td>
<td>PERCENTAGE DAMAGE ESTIMATE (%)</td>
<td>COST ESTIMATE (USD $)</td>
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<td></td>
<td><strong>TOTAL ESTIMATE</strong></td>
<td><strong>USD $</strong></td>
<td><strong>20,656,664.00</strong></td>
</tr>
</tbody>
</table>

As mentioned above, the estimates should be fine-tuned when additional detailed evaluations are completed.

March 2010