Concrete Hollow Blocks (CHB):

Concrete Hollow Blocks (CHB), are one of the most extensively used walling materials in the Philippines. Some of the reasons for this is their relative low cost when compared to other materials and speed of installation by semi-skilled labourers. CHB walls are very weak against lateral loads (pushing or pulling forces from typhoon or earthquake). Adding steel reinforcing bars vertically and horizontally inside the CHBs can increase their resistance to lateral loads.

Typical applications in humanitarian shelter projects

- As non-loadbearing infill between reinforced concrete columns and beams (frames). Often in humanitarian projects in the Philippines, CHBs are installed between reinforced concrete columns up to the window sill level, then lightweight walling materials such as timber framing cladded with amakan, plywood or bamboo are installed above (Figure 1).
- As loadbearing infill between reinforced concrete columns and beams in confined masonry buildings. The CHBs are reinforced with vertical and horizontal steel bars connected to the reinforced concrete columns and beams, increasing their resistance to lateral loads.
- As load bearing reinforced CHB in reinforced masonry buildings. The CHBs are reinforced with vertical and horizontal steel bars increasing their resistance to lateral loads.

Figure 1: Concrete blocks have been installed between the reinforced concrete columns, up to the level of the window sill of this core shelter in Tabontabon, Leyte. Credit: Philippines Red Cross Haiyan Shelter Programme (Photo W. Eastwood)

Background information

Advantages

- Readily available product
- Good thermal and sound resistance
- High fire resistance
- Can be reinforced to increase lateral resistance against earthquakes and typhoons
- 20+ years lifespan

Challenges

- Local sourcing of good quality raw materials and CHBs can be difficult

Standard product size in the Philippines	Length – 40cm, Height – 20cm, Depth 10cm (4”) and 15 cm (6”)
Product and material quality	Crushed coarse sand or gravel is optimal for the manufacture of CHBs. Avoid sand sourced from rivers and coastal areas (sea sand). The quality of CHBs varies significantly from one supplier to the next.
Suppliers	**Sand and gravel**: Widely available in the Visayas region from local suppliers. **Cement:** As above **CHBs:** It is recommended to procure products from suppliers with products certified by the Department of Trade and Industry (DTI) and Department of Public Works and Highways (DPWH). Check for PS and ICC markings on the cement to ensure product meets required specifications. (Refer to reference section for further information).
Environmental considerations	Consider more environmentally friendly alternatives where available, eg: Interlocking compressed earth blocks (ICEB), Case study: http://www.rafi.org.ph/news-highlights/houses-bajaus

Existing standards for CHBs and CHB wall construction in the Philippines:	
National Building Code of the Philippines and National Structural Code of the Philippines, NSCP.	
Load bearing walls	6" CHBs
	CHBs used must be Type I Class A or B unit, confirming with ASTM C-90-70
Minimum compressive strength	5.41 Mpa (800psi) - For individual CHBs 6.89Mpa (1000psi) - Based on the average gross area of 5 units
Non-load bearing walls	4" CHBs
	Applications include: walls, partitions, fences, dividers
Steel bars	To be laid in mortar 1 part of Portland cement and 3 parts of sand (1:3) Vertical and horizontal spacing as specified by a structural engineer.
Mortar and grout	Type 1,2,3 or Type 4 Portland Cement confirming to ASTM C-150. Standard mix to the building code specifications

Proportioning of concrete for the manufacture of CHBs	
This is done in two different ways	By weight or volume. The most common method is by volume (e.g. using a bucket)
Mixture	For CHBs: Mix Proportion 1:7, as per structural engineer's specification
Water	Clean water should be used. Shall not exceed 28 litres per 40 kilograms per bag of cement, slump test (as per ASTM C-143) shall not exceed 10cm, unless specified by a structural engineer.
Common CHB mix:	 ½ bucket water 1 bucket cement 7 buckets sand
Common mortar mix:	 1 bucket water 1 bucket cement 3 buckets sand
Mixing time	If batch mixer is used, use accurate timing and measuring devices to operate as per manufacturer's instructions. Revolutions should be between 14 and 20 per minute.
Curing	After being removed from the mould, the CHBs should be covered with a plastic sheet or tarpaulin and kept damp and shaded for at least 7 days in order to effectively cure. This can be achieved by continually spraying them with water or keeping them under water in tanks. A good curing process leads to less cracking and a stronger, harder, denser and more durable concrete.

CHB tips
✓ **Selection of raw materials for the manufacture of CHBs:** It is recommended to use good quality, clean ingredients. Avoid using beach sand as it contains salt which significantly compromises the quality of concrete.
✓ **Proportions of materials in mixture:** Mix concrete well, using the proportions specified by a structural engineer. Ensure that an adequate amount of cement is added and avoid adding excessive water as it weakens the mixture. Concrete should stand up when mixed, not flow away due to excessive water.
✓ **Mixing:** Use a mixing board otherwise water used for mixing will percolate into the ground and impurities such as dirt and grass could become incorporated into the mixture. If concrete is mixed in batches, maintain consistent proportions for all batches.
✓ **Pouring and compaction:** Ensure the formwork is clean before pouring and vibrate uniformly. The concrete should be well compacted in order to make sure that any air which is trapped in the concrete (weak points) is removed.
✓ **Curing:** Avoid using freshly made, uncured CHBs as they are still in a state of shrinkage.
✓ **Storage:** Store CHBs for at least 14 days after curing before using them. Protect them from rain and ground water, stacking them in a way which allows air to circulate around and between them.
✓ **Transportation:** Minimize excessive handling and transportation of CHBs to avoid damage

✓	**Selection and quality control of CHBs:** It is recommended to test the compressive strength of CHBs produced/purchased in order to ensure they meet the required strength. Select only strong CHBs. Blocks with cracks and corners crumbling away when handled suggests poor quality. If the CHB breaks when dropped from head height, don't use it or other blocks in the same batch.
✓	**Construction:** Dampen CHBs before laying as dry masonry absorbs water from the cement, weakening the joint. CHBs should always be laid on a full bed of mortar and vertical joints should always be filled.
✓	**Earthquake and typhoon resistance:** In order to increase the building's resistance against lateral loads (pushing or pulling forces from typhoon or earthquake), connect CHB walls to the reinforced concrete columns and beams with vertical and horizontal steel reinforcing bars, in accordance with structural engineer's details.
✓	**Maintenance:** Consider plastering/rendering the surface of CHB walls in order to avoid excess absorption of moisture into the wall and to facilitate periodic cleaning.

Some useful reference documents on concrete hollow blocks in the Philippines:	
For information on CHBs and the **Building Code of the Philippines**	Arellano V. Busto. (2014) *Building Code of the Philippines.* Manila, Philippines: A.V.B Printing Press.
For further information on the design of concrete	Max B. Fajardo Jr. (1999) *Specifications and Contract.* Philippines.
This guidance by Build Change provides a list of 10 recommendations for Masonry Structures	Post-Disaster Reconnaissance Report Damage Assessment and Housing and Markets Survey 2013 Bohol Earthquake and Typhoon Yolanda 31 January 2014, revised 5 February 2014 http://www.buildchange.org/pdfs/Build%20Change_Philippines%20Reconnaissance%20Report.pdf
Tips on making your home stronger and safer with information on masonry construction. This is a leaflet developed by Build Change in response to the 2013 Bohol earthquake. Available in English and Boholano	http://www.buildchange.org/pdfs/2014-01_BC_PH%20Masonry%20IEC%20Leaflet_(EN)(HiRes).pdf
You can keep your family safe in future earthquakes and typhoons. This is a poster developed by Build Change for masonry construction in response to the 2013 Bohol earthquake. Available in English and Boholano	http://www.buildchange.org/pdfs/2014-01_BC_PH%20Masonry%20IEC%20Poster_(EN)(HiRes).pdf
Other Build Change technical resources relevant masonry construction	http://www.buildchange.org/tech/BC_SixPermanent-english.pdf
Consumer's Guide, Product Quality and Safety: Cement. Bureau of Product Standards, Department of Trade and Industry, Philippines	http://www.bps.dti.gov.ph/information-materials/doc_download/3-consumers-guide-on-cement.html

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