**Compressed Earth Block** often referred to simply as **CEB**, is a type of manufactured construction material formed in a mechanical press that forms an appropriate mix of dirt, non-expansive clay, and an aggregate into a compressed block. Creating CEBs differs from rammed earth in that the latter uses a larger formwork into which earth is poured and tamped down, creating larger forms such as a whole wall or more at one time. CEB blocks are installed onto the wall by hand and a slurry made of a soupy version of the same dirt/clay mix, sans aggregate, is spread or brushed very thinly between the blocks for bonding. There is no use of mortar in the traditional sense. (This is not necessarily true for vertical presses, see link at bottom of page)

The advance of CEB into the construction industry has been driven by manufacturers of the mechanical presses, a small group of eco-friendly contractors and by cultural acceptance of the medium in areas where it is seen as superior to adobe. In the United States, most general contractors building with CEB are in the Southwestern states: New Mexico, Colorado, Arizona, California, and to a lesser extent in Texas. However, manufacturers of the mechanical presses enjoy their heaviest sales overseas. Mexico and Third World countries have been attractive markets for the presses for years.

The advantages of CEB are in the wait time for material, the elimination of shipping cost, the low moisture content, and the uniformity of the block thereby minimizing, if not eliminating the use of mortar and decreasing both the labor and materials costs.

- CEB can be pressed from humid earth. Because it is not wet, the drying time is much shorter. Some soil conditions permit the blocks to go straight from the press onto the wall. A single mechanical press can produce from 800 to over 5,000 blocks per day, enough to build a 1,200 square feet (110 $m^2$) house in one day. The Liberator, a high performance, open source CEB press, can produce from 8,000 to over 17,000 blocks per day.

- Shipping cost: Suitable soils are often available at or near the construction site. Adobe and CEB are of similar weight, but distance from a source supply gives CEB an advantage. Also, CEB can be made available in places where adobe manufacturing operations are non-existent.

- Uniformity: CEB can be manufactured to a predictable size and has true flat sides and 90-degree angle edges. This makes design and costing easier. This also provides the contractor the option of making the exteriors look like conventional stucco houses.

CEB had very limited use prior to the 1980s. It was known in the 1950s in South America, where the Cinva Ram was developed by Raul Ramirez in the Inter-American Housing Center (CINVA) in Bogota, Colombia. The Cinva Ram is a lever-action, manual press that makes one block at a time.

U.S. manufacturers produce much larger machines that run with diesel or gasoline engines and hydraulic presses that receive the soil/aggregate mixture through a hopper. This is fed into a chamber to create a block that is then ejected onto a conveyor.

During the 1980s, soil-pressing technology became widespread. France, England, Germany and Switzerland began to write standards. The Peace Corps, USAID, Habitat for Humanity and other programs began to implement it into housing projects.

Construction method is simple. Less skilled labor is required; wall construction can be done with unskilled labor encouraging self-sufficiency and community involvement. If the blocks are stabilized with cement and/or fly ash, they can be used as bricks and assembled using standard masonry techniques of brick-laying.

Soil mix conditions: The soil mix is 15-40 percent non-expansive clay, 25-40 percent silt powder, and sharp sand to small gravel content of 40-70 percent. The more modern machines do not require aggregate (rock) to make a strong soil block for most applications. Soil moisture content ranges from 4 to 12 percent by weight. Clay with a plasticity index (PI) of up to 25 or 30 would be acceptable for most applications. The PI of the mixed soil (clay, silt and sand/gravel combined) should not exceed 12 to 15; that is the difference between the Upper and Lower Atterberg limits, as determined by laboratory testing.

Other advantages:

- Non-toxic: materials are completely natural and do not out-gas toxic chemicals
- Sound resistant: an important feature in high-density neighborhoods, residential areas adjacent to industrial zones
- Fire resistant: earthen walls do not burn
- Insect resistant: the walls are solid and very dense, discouraging insects
- Mold resistant: there is no cellulose material - such as in wood, Oriented Strand Board or drywall - that can host mold

Completed walls require either a reinforced bond beam or a ring beam on top or between floors (8')and if the blocks are unstabilized, a plaster finish, usually stucco wire/stucco cement and or lime plaster. Stabilized blocks create a brick wall that if properly stabilized can be left exposed with no outer plaster finish.

Foundations: Standards for foundations are similar to those for brick walls. A CEB wall is heavy. Footings must be at last 10 inches thick, with a minimum width that is 33 percent greater than the wall width. If a stem wall is used, it shall extend to an elevation not less than eight inches (203 mm) above the exterior finish grade. Rubble-filled foundation trench designs with a reinforced concrete grade beam above are allowed to support CEB construction.

CEB's strongest market in the USA is probably New Mexico, which has incorporated the method into its Earth building Code family. The first CEB Code Development meeting in New Mexico took place Dec. 12, 2001. The persons present at that meeting are considered today the leading experts in the field. They include:

- Fermin Aragon, general bureau chief of the Construction Industries Division for Santa Fe, New Mexico
- Joe M. Tibbets, publisher of Adobe Builder Trade Publications, Bosque, New Mexico
- Larry Elkins, Adobe International Inc.
- Jim Hallock, Earth Block Inc.
- Lawrence Jetter, A.E.C.T
- Jim Hands, P.E., Red Mountain Engineering
- Todd Swanson, Bio-Hab Inc.
- Joaquim Karcher, architect, Taos

Code work was completed June 10, 2002 and melded into New Mexico's new section, R1100 Earthen Building Materials.

The CEB code is different from the adobe code in numerous respects. For instance, the CEB code allows slip mortars and permits blocks ejected from a press to go directly to the wall.

**CEB Strength:** Using the ASTM D1633-00 stabilization standard, a pressed and cured block must be submerged in water for four hours. It is then pulled from the water and immediately subjected to a compression test. The blocks must score at least a 300 pound-force per square inch (p.s.i) (2 MPa) minimum. This is a higher standard than for adobe, which must score an *average* of at least 300 p.s.i. (2 MPa)

It must be emphasized that the compressive strength minimums for code compliance are nothing like the true strength of CEB blocks. New Mexico only sought to assure that CEB would be at least as strong as adobe.

CEB can have a compressive strength as high as 2,000 pounds per square inch ($13.7\times10^6$ Pa). Blocks with compressive strengths of 1,200 ($8.27\times10^6$ Pa) to 1,400 p.s.i. ($9.65\times10^6$ Pa) are common.

**Thermal advantages:** Also, due to the enormous mass - these are monolithic walls - CEB has excellent thermal performance, reducing heating and cooling costs.

Thermal testing: From May 31 to June 3, 2004, the Biology Dept. of Southwest Texas Junior College, Del Rio, Texas, conducted tests for thermal change on three structures: concrete block, adobe and compressed earth block.

Results indicate the interior temperature of the adobe and CEB modules were significantly lower than for concrete blocks.

With a maximum ambient temperature of 107 °F (42 °C), the interior temperatures were:

Concrete Module: 111 °F (44 °C) (four degrees Fahrenheit above ambient)
Adobe Module: 95 °F (35 °C)
CEB Module: 91 °F (33 °C)

The CEB module was consistently cooler inside than the adobe by approximately 3 degrees.