The pavilion was built with the best of nature, combined with the technology and creativity of the human being, applying concepts of sustainability and building techniques that led it to be one of the most prominent and admired in Hanover; therefore, it represented conclusively the theme of the EXPO: “Nature, humanity and technology”. The ZERI pavilion is also a symbol of: biodiversity, synergy, creativity, new economy, tolerance, XXI century architecture, faith and hope, perseverance, sustainability, youth and perhaps many more.

In addition to the structural, earthquake-resistant and aesthetic qualities of bamboo (guadua) it is a species that fixes 40 times more carbon dioxide than wood, this kind of construction could be funded by the CO2 emissions rights for those who pollute the environment, thus supporting the most needy people and financing social housing.
“The ZERI Pavilion is a rich symbol offering a message, which goes beyond the mere building itself. The ZERI Pavilion offers a number of symbols to the world.” Gunter Pauli

BIODIVERSITY
It includes a plant, a flower and two types of grasses, which come from the same Andean ecosystem, with natural coloring from insects and preservation agents extracted from the same bamboo, which preserves itself against insects and molds.

SYNERGY
The best of nature is combined with the most creative forms of humanity, i.e. steel and cement. The performance of bamboo is dramatically enhanced with the technique of making joints with cement and iron.

CREATIVITY
There are one hundred million people without a home. ZERI uses waste (used bottles) and weeds (bamboo, aliso and arboloco are considered weeds) for cheap, functional and beautiful housing as summarized in the book "Grow Your Own House" which is based on the experience gained in this pavilion.

NEW ECONOMY
The present economy is good, but not good enough. The world needs a better production and consumption system, we need many more jobs. The ZERI Pavilion includes new building materials, grown and harvested sustainably, it demonstrates a preservation system eliminating toxic chemicals, and as such it creates new work and income.
TOLERANCE
The ZERI Pavilion does not have an entrance nor an exit, it symbolizes the open mind, where all paths are welcome, from wherever they come, but having the same desire, to do more and better to respond to people’s needs around the world.

21st CENTURY ARCHITECTURE
The ZERI Pavilion presents 7 new building techniques and 2 new construction materials approved by the German authorities, it offers a building method offering people a house which dances along with the movements of the Earth, and it is cheap.

BELIEF AND HOPE
The Pavilion was built without previous experience, without a clear budget, without a guarantee that the final permits would actually be obtained, though everyone who collaborated believed that it would be possible, and gathered all the energy needed to make it happen. And it did happen!

PERSEVERANCE
The ZERI Foundation proposed to build the pavilion twice, once in Colombia in order to undertake the stringent stability tests by German professors, which were passed, to then build it at the World Expo. Never in history has anyone built twice any construction to be able to be present at an Expo. The cost of tests and approvals is higher than the building costs.
SUSTAINABILITY
This building sequestered as much carbon dioxide as was needed to make it. Bamboo and arboloco used in ZERI housing, and fixed 40 times more carbon dioxide than timber; this building system could actually be financed with the CO2 emission rights that the rich are offering the poor. Those who contaminate too much can now pay for social housing.

YOUTHFULNESS
The first ever event held at the ZERI Pavilion was a congress gathering 2,000 young people from around the world who saw in this building an opportunity to contribute to a better world. At the ZERI Pavilion, over 100 volunteers welcomed everyone in nearly 40 different languages. It is an inspiration for all.

ZERI
There is no better symbol for the work ZERI wants to achieve, “use all waste and weed to generate food and housing”. This pavilion demonstrates that it is possible, and that it is cheap, therefore becoming a symbol for the poorest of the poor who now can take pride in their natural building materials. It is the same for our programs “beer bakes bread”, “cement factory goes organic”, “water hyacinth fights AIDS”.

EXPO
The ZERI Pavilion could very well become the symbol of the World EXPO. It is the only one considered a masterpiece by academics, which lead to the issuance of a diploma to all the workers. But more important, it is the only Pavilion, which introduces 7 new structural building systems, and 2 new building materials that were totally unknown to Germans. It is probably the best case of the theme “Nature-Humanity-Technology”.
The pavilion was designed in a way that pushed the limits of materials and technologies, and knowledge gained immediately benefiting the less fortunate in social housing.

**Form:** Ten sided polygon inscribed in a circle (diameter=40m)

**Area:**
- Site 2.150m²
- Foundations 684 m²
- Mezzanine 458 m²
- Roof 1.306 m²

**Height:**
- Total 14.40 m
- Mezzanine 4.50 m

**Weight:**
- Guadua, Aliso, Arboloco and Chusque 100 Ton
- Steel and Iron 10 Ton
- Concrete 75 Ton
- Total 500 Ton

**Roof slope:** 33.3% = 17°

**Columns:**
- 40 aliso columns (20 interior – 20 exterior)
- 40 guadua columns on the second floor (20 interior – 20 exterior)
- Columns slope: 20% = 79°

**Access to the mezzanine:**
- Two spiral staircases from steel and bamboo.

**Overhang length:**
- 7.00 m
MATERIALS

Guadua

Family: Gramineae
Species: Guadua angustifolia, Kunth
Geographical distribution: Grows in the north of South America. Grows naturally in Colombia, Panama, Venezuela, Ecuador and Peru.
Ecology: Grows in fertile, rich and humid grounds at altitudes between 400 and 2000 msnm.
Maximum size of tree trunk: Height 25 m.
Diameter: 10–15 cm.
Environment: The compost of guadua leaves protect the earth and its extensive root system secures the existence of water.

*Utilization in the pavilion: Beams, structure of the double flooring, internal columns, "flutes" (extensions of the columns), support of the roof, crowns and rings.
Aliso

Family: Betulaceae
Species: Alnus acuminata, Humboldt, Bonpland and Kunth.
Geographical distribution: Grows in South America in countries like Bolivia, Chile, Ecuador, Peru and Venezuela.
Ecology: Grows at altitudes between 2100 and 3000 msnm. Prefers humid grounds.
Maximum size of tree trunk: Height 35 m.
Diameter: 75 cm.
Mechanical qualities: (Galanta 1953)
- Specific weight: 0.325 to 0.461 kg/dm²
- Hardness according to Brinell 4.7 kg/cm² (tender)
- Resistance to traction 108 kg/cm²
- Resistance to the parallel compression of the fibre 357 kg/cm²
- Resistance to the perpendicular compression of the fibre 68 kg/cm²
- Cutting resistance 96 kg/cm²
- Bending resistance 504 kg/cm²

*Utilization in the pavilion: Main Columns
Arboloco

Family: Asteraceae
Species: Montanoa quadrangularis, Schultz Bip. In K.Koch
Geographical distribution: The Andean Zone of Colombia and Venezuela.
Ecology: Grows at altitudes between 1500 and 2500 msnm.
Maximum size of tree trunk: Height 20 m.
Diameter: 50 cm.
Mechanical qualities: (Galanta 1953)
- Specific weight: 0.68 kg/dm²
- Hardness according to Brinell 860.25 kg/cm²
- Resistance to traction 500 to 1500 kg/cm²
- Resistance to the parallel compression of the fibre 405 kg/cm²
- Resistance to the perpendicular compression of the fibre 131.71 kg/cm²
- Cutting resistance 111.27 kg/cm²
- Bending resistance 903 kg/cm²

*Utilization in the pavilion: Beams in the double flooring.
Chusque

Family: Poaceae Gramineae
Species: Chusquea serrulata, Pilger
Geographical distribution: Grows in high barren plateaus in the Central and Oriental mountain range of the Andes.
Environment: Chusque secures riverbanks and protects rivers from evaporation, due to the shade it provides. Chusque also has an esthetical value in gardens.

*Utilization in the pavilion: Woven into the double flooring.
OTHERS

CONCRETE: Roof, Footings, Guadua chambers and mezzanine

IRON WASHERS:
- Small washer:
  Quantity: 2224
  Weight: 0.14 Kg
  Diameter: 6cm
  Hole diameter: 2cm
  Shape: Curve
  Where? Along the alisos to fix them

- Medium washer:
  Quantity: 918
  Weight: 0.66 Kg
  Diameter: 12cm
  Hole diameter: 2cm
  Shape: Flat
  Where? At the end of the roots and Pie de amigos

- Big Washer:
  Quantity: 80
  Weight: 3.95 Kg
  Diameter: 20cm
  Hole diameter: 3cm
  Shape: Cup
  Where? Between the alisos and concrete footings

From left up to right down: Roof, Footings, Guadua chambers and Mezzanine.
TECHNICAL ANALYSIS OF DUCTILE CASTING

Pieces casted in Ductile Iron based in the standards ASTM A 536, Grade 65-45-12:
65 – Tensile strength min.: 65000 psi
45 – Yield strength min.: 45000 psi
12 – Elongation in 2 in. or 50 mm

CHEMICAL COMPOSITION
% Carbon (C) 3.80% – 4.00%
% Silicio (Si) 2.40% – 3.00%
% Manganese (Mn) 0.20% – 0.35%
% Phosphorus (P) <0.30%
% Magnesium (Mg) <0.30% – 0.08%
% Other elements <0.08%

METALOGRAPHIC STRUCTURE
% Nodulizacion >80%
Nodulos/mm² >150
% Ferrita >60
% Perlita <30

SCREWS, NUTS AND WASHERS:

SCREWS
80 of 1” x 1m
1.060 of ½” x 3m
192 of ½” x 1m
195 of 5/8” x 3 m
87 of ¾” x 3m
160 of 5/16” x 1m

NUTS
80 of 1”
650 of ¾”
2.150 of 5/8”
23.455 of ½”
1.700 of 5/16”

WASHERS
20.135 of ½”
1.700 of 5/16”
METALLIC STRAPS: Manual bending process. Used to attach the alisos, to give stability to the columns.

EXPANDED METAL: To support and reinforce the layer of concrete in the roof.
WIRE: Chicken wire in the mezzanine, to protect the chusque during the concrete work, and wire ties to secure the intersection of reinforcement bars.

RECYCLED BOTTLES: The function is to contain the concrete, which is injected to the guadua and give it the form. All the bottles used are from own consumption waste (glass bottles of water and champagne and plastic bottles).
MACANA: The macanas can be made from several palms, but those that were used in the pavilion are from the Chontaduro or Chonta palm (Ceroxylon andicola). They are traditionally used in Colombia. Delivered by Gabriel Germán Londoño.

Diameter: 3 cm

Quantity: 1500

BONGOSI: Support for the guadua roots in the aliso columns. Imported from Africa.

Bend: 25N/mm²
Tension: 15 N/mm²
Pressure: 20 N/mm²
Cutter, cutting strength: 2 N/mm²
Tensile strength βII: 180 N/mm²
Compressive strength βDII:
  95 N/mm²
Flexural strength βB: 180 N/mm²
Shear strength Ta: 14 N/mm²
Bulk density N: 1,06 g/cm³

Elastizitätsmoduln:
ET 1/S11 2060 N/mm²
EL 1/S22 17000 N/mm²
ER 1/S33 3230 N/mm²
ASKA BOARD: Product from Teiheiyo Cement (Japan), Made in Indonesia. Composition: 50% cement and 50% bamboo fiber. Measure 910x1820x9 mm. Quantity 1420 slates.

ROOFING FELT: Waterproofing. Copper and bituminous felt (hot application).
TOOLS

Drills, hammers (industrial and handmade), concrete mixer, handsaw, frame handsaw, mortise chisel to make the “fish mouth”, plumb line, plane, ropes to lift tools and materials, belts to tighten the guadua during the process of the joints.
SUPPORT FOR PILLARS: By inclining the columns added support is achieved, making the pavilion stable and adding to its indifference to earthquakes.

FIBER AND CEMENT: The combination of bamboo fiber and cement is an innovation that can replace the asbestos in cement with natural fibers. This technology is using in the making of the roof of the pavilion.
CEMENT AND GUADUA: Cement filled into the cañutos, the open chambers of the guadua, serve as reinforcement at the supportive points and also secures the iron fittings.

GUADUA ROOTS: This supportive construction uses the solid guadua roots to strengthen the structural system of the pavilion.
PILLARS: Pillars made out of concrete protect the wood from humidity coming from earth.

SMOKED GUADUA: Immunization through the smoking of the guadua is a productive and sustainable alternative to chemicals used today. Speed of immunization is radically decreased, as is pollution.
OVERHANG: The length of the eaves protects the wood structure from water.
The prototype of ZERI pavilion in Manizales was made with the original sketches of Architect Simón Vélez.

To get the construction approval in Germany we had to make the complete drawings with all the structure details. Then the drawings were reformed and approved by, Dipl. Eng. Josef Lindemann and German authorities.
Simón Vélez Sketches
ZERI Pavilion for EXPO 2000


Approved Drawings
2/12

Monday, August 11, 14
ZERI Pavilion for EXPO 2000


Approved Drawings
5/12
Approved Drawings
6/12
Approved Drawings
8/12
ZERI Pavilion for EXPO 2000


Approved Drawings
9/12
ZERI Pavilion for EXPO 2000


Approved Drawings
12/12
The ZERI pavilion is like traveling to the moon. It pushes the construction techniques to the limits. Thanks to this experience, and thanks to new technologies recently acquired in Japan, a low cost house of less than 25 million Colombian pesos, which is about US$10,000, can be constructed. The house is beautiful, functional and insensitive to the earthquakes and cheap. It has 65 square meters with a balcony, distributed over two floors.
Grasses like bamboo are the world’s most renewable source of building material, growing 13 cm per day. Bamboo is harvested at 4–5 years of age and because it is a grass, it grows again immediately. Trees take minimum seven years to harvest time, and never grow again. ZERI scientists adapted a Japanese method of preserving bamboo with its own chemicals over two floors. Simón Vélez developed new building techniques to create both, the ZERI pavilion and affordable homes. A 500 m² plot of bamboo yields the necessary amount for one house each year.
Before the construction process, there were some stages developed in Colombia. The previous stages were very important in order to obtain the German permits.

Prototype – Manizales, Colombia

1. SELECTION AND CUT OF MATERIALS
2. QUALITY CONTROL
3. IMMUNIZATION
4. LOAD AND UNLOAD MATERIALS
Guadua

Donated by Sr. Gabriel German Londoño Gutierrez from his farm "San Jorge" located in Pereira - Colombia (extreme coordinates latitude N 4° 45' - 4° 50' longitude W 75° 40' - 75° 55'). Zona Cafetera 1250 meters above sea level – 1900 mm of annual rainfall and 24° C average temperature. Cut in decreasing moon 3,500 pieces of guadua (9 m long) and 240 guadua roots.
Aliso

Donated by Aguas de Manizales S.A. E.S.P. from its farm "Río Blanco" located in Manizales – Colombia. Zona Cafetera 2150 meters above sea level – 17º C average temperature. Diego Uribe was in charge of cutting the 200 aliso logs.

Arboloco

Some of the logs were donated by Aguas de Manizales S.A. E.S.P. from its farm "Río Blanco". The others were bought from Maderas y Celulosa S.A. in Manizales. Zona Cafetera 2150 meters above sea level – 17º C average temperature. Diego Uribe was in charge of cutting the 80 arboloco logs (160 half pieces).

1. SELECTION AND CUT OF MATERIALS
2. QUALITY CONTROL
3. IMMUNIZATION
4. LOAD AND UNLOAD MATERIALS
Chusque

Donated by the Comite de Cafeteros de Caldas from its farm "Pedro Uribe Mejía" located in Manizales - Colombia. Zona Cafetera 2150 meters above sea level - 17º C average temperature. 8000 pieces of chusque (3m long) carried by mules.
The German authorities request a quality control of aliso logs according to DIN 4074.

The guadua quality control was made according to a standard created by Colombian experts and German engineers, especially for this construction.

Quality control was not necessary for arboloco and chusque.
Aliso Quality Control

Quality control was performed to every single log. Pablo Atehortua, responsible for the construction of the ZERI pavilion and the architect Simon Velez, revised all the logs. They affirmed that the quality of the aliso was excellent and even better than the logs used for the pavilion constructed in Manizales.

The alisos were also checked and approved by Luis Miguel Alvarez, agronomy professor of Caldas University. After hearing the points of view of these people, the Quality Control requested by the German engineer Josef Lindemann, according to the DIN 4074 standards, was made by Pamela Salazar (Industrial Designer) and Carolina Salazar (Architect).

The diameters of the logs should be from 18 to 25 cm.
Aliso Quality Control

This form was filled for every single log with 4 different tests. The logs should be in Class I or II according to the DIN 4074 standard.

1. SELECTION AND CUT OF MATERIALS
2. QUALITY CONTROL
3. IMMUNIZATION
4. LOAD AND UNLOAD MATERIALS
Guadua Quality Control

Class I (yellow lines)
Top: cross-sectional area $A > 40 \text{ cm}^2$ and $\varnothing \geq 10 \text{ cm}$ (e.g. $\varnothing 10, t=15 \text{ mm}$)
Base: cross-sectional area $A \geq 55 \text{ cm}^2$ (e.g. $\varnothing 14, t=15 \text{ mm}$ or $\varnothing 12, t=20\text{mm}$)
Middle: cross-sectional area $A \approx 47 \text{ cm}^2$ ($\varnothing 12, t=15 \text{ mm}$) and $\varnothing \geq 12 \text{ cm}$)

Class II (blue lines)
Top: cross-sectional area $A > 30 \text{ cm}^2$ and $\varnothing \geq 10 \text{ cm}$ (e.g. $\varnothing 10, t=11 \text{ mm}$)
Base: cross-sectional area $A \geq 40 \text{ cm}^2$ (e.g. $\varnothing 12, t=12 \text{ mm}$)
Middle: cross-sectional area $A \geq 35 \text{ cm}^2$ and $\varnothing \geq 11 \text{ cm}$ ($\varnothing 11, t=11 \text{ mm}$)

Class III
The guaduas that do not match Class I and II, are not good for construction.

1. SELECTION AND CUT OF MATERIALS
2. QUALITY CONTROL
3. IMMUNIZATION
4. LOAD AND UNLOAD MATERIALS
Every single guadua was immunized with smoke technique; this process involves treating the bamboo with its own chemicals, to protect it from insects and fungus. This technique was used in Japan, and now is being taken up to replace the toxic chemicals. The guadua used in the ZERI pavilion was immunized in two ovens in Colombia, most of them in Armenia, by Antonio Giraldo and the others in Pereira by Gabriel German Londoño, both in Colombia.

1. SELECTION AND CUT OF MATERIALS
2. QUALITY CONTROL
3. IMMUNIZATION
4. LOAD AND UNLOAD MATERIALS
Manizales: Two containers with Alisos, and one with Arboloco and Chusque. Pereira: Ten containers with Guadua, Guadua roots and Macanas.

Most of the containers departed from Cartagena Port (Atlantic Ocean) and the others from Buenaventura Port (Pacific Ocean) in Colombia. They all arrived in Hamburgo Port in Germany, and then the containers were transported by trucks to Hannover. The transportation between Colombian and German ports took approximately 24 days. Panalpina was the company in charge of the transportation.

1. SELECTION AND CUT OF MATERIALS
2. QUALITY CONTROL
3. IMMUNIZATION
4. LOAD AND UNLOAD MATERIALS
STAGES

STAGE 1: The excavations and foundations were done by German workers.

STAGE 2: Scaffolding – setting up elevation marks – installation of guadua rings – preparation of aliso.
STAGE 4: Construction of tuss, beams and diagonal support.

STAGE 3: Installation of columns and guadua support rings – reinforcement of roof.
STAGE 5: Reinforcement of floor by weaving together arboloco, chusque, iron and concrete.

Stage 6: Finishing
### ZERI Pavilion for EXPO 2000


**Preliminary Stages . Construction Stages & Timeline . Construction Techniques . Details**

#### TIMELINE

**COLOMBIA:** eight months to build the pavilion

**GERMANY:** three months and two weeks

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**Monday, August 11, 14**
FILLING THE CAÑUTOS (internal chambers of bamboo) with a mix of cement, sand and water.
FILLING THE CAÑUTOS (internal chambers of bamboo) with a mix of cement, sand and water.
FISH MOUTH: Handmade technique to fit a bamboo with another.
CONCRETE ROUND BASES
(MADE BY HAND)
BOTTLES

1  2  3  4  5

Monday, August 11, 14
ZERI Pavilion for EXPO 2000

Preliminary Stages . Construction Stages & Timeline . Construction Techniques . Details

BAMBOO PARKET

STAIRCASE
RAILINGS

COCHINILLA (Dactylopius coccus) phytophagous insect parasite that lives as a guest of the tuna belongs to the family Dactylopiidae. The cochinilla insect is mainly used for the extraction of the dye compound of two substances known as carmine and carminic acid.
Experimental evaluation of the load-bearing properties of the Pavilion, by Prof. Dr. – Ing. Klaus Steffens from the Experimental Statics Institute at the University of Bremen, Germany.

Professor Klaus Steffens – director since 1980 of the Institute of Experimental Statics of the University of Bremen – has realized experimental evaluations of load bearing and safety for the reconstruction of the Reichstag building in Berlin, among others.

1. Cantilever-roof

Experimental trial burden: F=6.5kN

Consisted of determining the load bearing capacity of the cantilevers (a 7.30 meters overhang). This was done by hanging a weight of more than 650 kilograms in the middle third of their spans. A deformation of 7 millimeters was observed, which the structure recovered when it was freed of the burden.
Experimental evaluation of the load-bearing properties of the Pavilion, by Prof. Dr. – Ing. Klaus Steffens from the Experimental Statics Institute at the University of Bremen, Germany.

2. Ceiling of gallery

Experimental trial burden: \( F = 4.0 \text{kN/m}^2 \)

Ceiling level 1: net weight + 2.0 kN/m\(^2\) traffic load, including safety edge.

To test the capacity of the upper floor, this structure as loaded down with 55 gallon barrels, which were uniformly spread over the surface and filled with water until they reached a load of 400 kilograms per square meter. When the deformation of the upper floor under this burden was measured, it came to 5 millimeters, which were recovered when the weight was removed. It is important to note that the estimated deformation for this test was expected to reach 25 millimeters, which means that the result was a fifth of the estimate.
Experimental evaluation of the load-bearing properties of the Pavilion, by Prof. Dr. – Ing. Klaus Steffens from the Experimental Statics Institute at the University of Bremen, Germany.

3. Frame

Experimental trial burden: F=235 kN
Horizontal bracing: net weight + 2.0 kN/m² traffic load + wind load, both without safety factors.

The third test involved a simulation of wind stresses and consisted of pulling the structure in a horizontal direction. This was done by placing one cable in the middle part and another in the upper part of each one of the pediments of the pavilion and the subjecting each cable to a horizontal load of five tons. The result obtained was a horizontal displacement of one centimeter.
Experimental evaluation of the load-bearing properties of the Pavilion, by Prof. Dr. – Ing. Klaus Steffens from the Experimental Statics Institute at the University of Bremen, Germany.

After carrying out these tests in Manizales, Professor Steffens issued a technical assessment that helped to support the application for the construction permit that was granted for the pavilion in the Hannover Expo–2000 Fair.

This study was complemented by a structural calculation carried out by Professor Joseph Lindemann, an estimate that was based, in part, on the results of traction, compression and flexion tests done by him in Germany.

Thus guadua passed all the tests and was officially authorized for architectural use in one of the countries with the strictest construction codes in the world.
Experimental evaluation of the load-bearing properties of the Pavilion, by Prof. Dr. – Ing. Klaus Steffens from the Experimental Statics Institute at the University of Bremen, Germany.

Letter from Klaus Steffens to Josef Lindeman after the structural tests in Colombia:

Engineer
J. Lindemann,
Lange Lambe 19, 30150
Hannover, Fax 0049 511 196 66
Dear Mr. Lindemann:
I enclose the original results of the tests done to the cantilever roofs and the galleries. The deformations are surprisingly minimal and totally reversible without slow flow, even in the case of a continuous load.
In general, the building gives the impression of great solidity. There is no doubt that the pavilion will have no problems in Hannover, if it is done with the same quality. The execution of the manual work here is higher than the German standard. It seems to have the quality of fine carpentry!
Tomorrow we will do the horizontal test. Afterwards there will be a celebration! My presence here was necessary. There might not have been any progress this week without the general coordination of the tests that I carried out.
I am going to recommend, without hesitation, a rapid issuing of the partial construction permit, independently of Stuttgart, so that we are not vulnerable to setbacks due to lack of time.
Best wishes,
Klaus Steffens
Manizales 11–04–1999
Report by Dipl.-Ing. Josef Lindemann - Structural Analysis

Ingenieurgemeinschaft Speich, Hinkes, Lindemann

ZERI Pavilion zur EXPO 2000 in Hannover
Hir. 12099

Abschlußbericht zur Qualitätskontrolle Holz Aliso und Bambus Guadua

Holz: Aliso (Alnus acuminata):

Zur Überprüfung der Übernahmeinhalt der an die Baustelle gelieferten Materials mit dem für die Bauleistungen verwendeten Material wurden 3 m lange Probestücke an die FMPA Stuttgart gesendet.

Bambus: guadua angustifolia

Die Bambusstäbe wurden in der 6., 7. und 10. KW auf die Baustelle geliefert.


Die Qualität der eingebauten Bambusstäbe wurde stichprobenmäßig überwacht.

Von zwei Lieferungen wurden Probestücke ausgewählt und an die FMPA Stuttgart zur Überprüfung der Übernahmeinhalt der an die Baustelle gelieferten Materials mit dem für die Bauleistungen verwendeten Material gesendet.

J. Lindemann

Deutsche Bank 34, Konto-Nr. 5412200 (DLZ 200 750 24)
Ingenieurgemeinschaft Speich · Hinkes · Lindemann

Ministerium für Frauen, Arbeit und Soziales
d.H. Herrn Winkler
Gustav-Brathe-Allee 2
30169 Hannover

ZERI-Pavillon EXPO2000 in Hannover
Hier: Qualitätssicherung Holz Allso und Bambus Guadua

Sehr geehrter Herr Winkler,


In der 6. KW wurden das Holz Allso sowie die ersten Container Bambus anlieferter. Weitere Bambuslieferungen folgen in der 7. KW und Ende Februar. Im Folgenden wird der Stand der stufenweisen Qualitätssicherung dargestellt.

Holz Allso (ahus acuminatus):


Ein detaillierter, vollständiger Bericht wird vorgelegt.

Zu c) Die visuelle Qualitätssicherung erfolgt durch die FMPA Stuttgart.

Zu d) Die stichprobenartige Kontrolle durch den Prüfingenieur erfolgt im Zuge der Bauaufsicht.

Bambus (guadua angustifolia):

Qualitätssicherung für das Holz alias und den Bambus guadua

1. Holz alias
   b) In Hannover wird die Einstufung der Stämme nach DIN 4074 von der Ingenieurengemeinschaft Speich, Hinkes, Lindemann kontrolliert und bescheinigt.
   c) Im Rahmen der Bauüberwachung des Prüfingenieurs erfolgt eine stichprobenartige optische Kontrolle des Holzes.

2. Bambus guadua augustifolia
   a) Die Bambusstäbe für den Pavillon in Hannover wurden in Kolumbien von Herrn Gabriele German Londono ausgesucht und beurteilt. Ein Bericht über die Qualitätsprüfung wird vorgelegt.
   b) In Hannover wird die Qualitätsprüfung von der Ingenieurengemeinschaft Speich, Hinkes, Lindemann kontrolliert und bescheinigt.
   d) Im Rahmen der Bauüberwachung durch den Prüfingenieur erfolgt eine stichprobenartige Kontrolle der Bambusstäbe.
Report by Dipl.-Ing. Josef Lindemann – Structural Analysis


Klasse I: Die Bambusstäbe der Klasse I werden für die tragende Konstruktion eingesetzt.
- freie, reine Bambusstäbe,
- die Abmessungen entsprechen den Vorgaben der statischen Berechnung
- Zuf.: Querschnittfläche A > 40 cm² und Ø ≥ 16 cm (z.B. Ø100, t=15mm)
- Stamm: Querschnittfläche A ≥ 55 cm² (z.B. Ø134, t=15mm oder Ø123, t=30mm)
- im Mittel: Querschnittfläche A ≥ 47 cm² (Ø142, t=15mm) und Ø ≥ 12 cm

Klasse II: Die Bambusstäbe der Klasse II dürfen für die tragende Konstruktion nur eingesetzt werden, wenn vorher ein statischer Nachweis eine ausreichende Tragfähigkeit ergibt hat.
- weitgehend reine, reine Bambusstäbe
- Zuf.: Querschnittfläche A > 30 cm² und Ø ≥ 10 cm (z.B. Ø100, t=10mm)
- Stamm: Querschnittfläche A ≥ 40 cm² (z.B. Ø123, t=12mm)
- im Mittel: Querschnittfläche A ≥ 38 cm² und Ø ≥ 10 cm (Ø111, t=11mm)

Klasse III: Alle Bambusstäbe, die nicht der Klasse I oder II zugeordnet werden können. Diese Bambusstäbe werden nicht für die tragende Konstruktion, sondern nur für Montagezwecke eingesetzt.

Zu c) Die Qualitätssicherung erfolgt wie beschrieben durch die FMAA Stuttgart.

Zu d) Die nicht benannte Kontrolle durch den Bauingenieur erfolgt im Zuge der Bauausführung.

Mit freundlichen Grüßen
J. Lindemann

Verteilung:
- Prüfingenieur Wertheim,
- ZERI (Bamsteinh),
- FMAA Stuttgart
Hochfliegende Pläne für das Bambushaus

Neue Osnabrücker Zeitung


Some German media who wrote about the ZERI Pavilion:

Neue Osnabrücker Zeitung
ZERI Pavilion for EXPO 2000

Press . Pictures . People

Kurier am Sontag

"Bauen mit Bambus hat Zukunft"

Zurück in die Zukunft
Bremerväter überprüfen in Kolumbien Pavillon für die Expo 2000

KURIER AM SONNTAG

SONNTAGSAGAEGE VON WESER-KURIER . BREMER NACHRICHTEN - VERBANDER NACHRICHTEN

Monday, August 11, 14
Wie viel Druck darf auf alten Gemäuern lasten?

Bremer Statisch-Institut prüft Bauwerke in ganz Deutschland auf ihre Tragfähigkeit - Experimente können Millionen-Ausgaben sparen

Von Karoline Laskowsky


Steffen ist überzeugt, dass das Experimentieren notwendig ist, um zu lernen. "Wir müssen uns immer wieder fragen, ob unsere Methoden und Verfahren ausreichen, um die Belastbarkeit von Bauwerken richtig zu prüfen."


Ein Beispiel für ein solches Experiment ist der sogenannte "Steffen-Konstruktion". Dieses Projekt wurde im Rahmen der Expo 2000 in Hannover durchgeführt und diente als Demonstrationsbeispiel für die Belastbarkeit von Bauwerken.

Die Ergebnisse dieser Experimente werden von den Forschern dann in der Praxis angewendet, um sicherzustellen, dass Bauwerke nachhaltig und sicher sind.

Die Arbeit der Forscher zeigt, dass es notwendig ist, sich ständig mit neuen Methoden und Techniken auseinanderzusetzen, um die sich ständig entwickelnden Verfahren in der Architektur und Bauwesen weiterzuentwickeln.
Ausaller Welt

**Orkan am Bambus-Pavillon**

Expo-Gebäude aus Graz: Mit menschlichen Lasten wird die Statik getestet.

Die Stadtzeitung

**Hier hört man das Gras wachsen und die Wale singen**

Ungewöhnlicher Pavillon einer Stiftung auf der Expo 2000 in Hannover / Potentielle Revolution für die Baubranche / Kein Abfall

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**ZERI Pavilion for EXPO 2000**
Symbols • Design • Construction • Reports & Permits • EXPO 2000 • Gunter’s Fables

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Press • Pictures • People
ZERI Pavilion for EXPO 2000

Press . Pictures . People

Bus Stop
Show opening of the EXPO

Monday, August 11, 14
ZERI Pavilion for EXPO 2000

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SOCCER
Game
ZERI Pavilion Workers vs. Germans

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Winter
ZERI Pavilion for EXPO 2000

Press . Pictures . People

Surroundings
Kiosk
ZERI Pavilion for EXPO 2000

From idea to the construction, who has been involved?

... IDEA

GUNTER PAULI
Founder and director of ZERI Foundation, Belgium

PAOLO LUGARI
Founder and director of "Las Gaviotas", Colombia

SIMÓN VÉLEZ
Architect, Designer of the Pavilion, Colombia

CARLOS BERNAL QUINTERO
Director of ZERI Latin America, Colombia

MARIO CALDERÓN RIVERA
President of Camara de Comercio de Manizales, Colombia
From idea to the construction, who has been involved?

SABINE BODE
Architect, Project coordination, Germany

CAROLINA SALAZAR OCAMPO
Architect, Site supervision, Colombia

VOLKER WEHRMANN
Architect, Site direction, Germany

PABLO ATEHORTÚA
Foreman, Colombia
From idea to the construction, who has been involved?

TRADESMEN (22), Colombia.
John Fredy Alarcon Garcia
Luis Gonzaga Arroyave G.
Hector Alonso Cardenas B.
Carlos Arturo Castaneda E.
Jose Diego Corredor Uribe
Marco Aurelio Hernandez B.
Luis Albeiro Lopez Cifuentes
German Rios Rojas
Jose Ember Rojas Malambo
Fabio Zamudio Ocampo
Francisco Javier Sanchez C.
Jesus Maria Arroyave G.
Francisco Javier Cardenas B.
Alvaro Cuenca Alvarin
Mario de Jesus Garcia Banol
Gabriel Angel Gonzalez C.
Raul Emilio Guzman B.

Luis Guillermo Jimenez Gil
Jesus Orlando Sanchez F.
Jose Balmore Valencia G.
Edwin Villa Restrepo
Robinson Villa Restrepo

LABORERS (16), Colombia.
Luis Evelio Agudelo Cardona
Jose Ancizar Aguirre Jimenez
Jose Orlando Alarcon Garcia
Jose Octavio Alzate Gallego
Francisco Javier Arias Osorio
Alexander Jimenez Jaramillo
Carlos Alberto Franco Lopez
Luis Alfredo Lopez Cardona
Jose Javier Medina Abril
Andres Felipe Rios Rojas

Jose Alexander Rojas M.
John Jairo Gutierrez Duran
Jose Norbey Arroyave G.
Alfredo Giraldo
Neftali Giraldo
Nelson Naranjo Mira
From idea to the construction, who has been involved?

... SUPERVISING AND APPROVAL

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HILMAR ZANDER
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Dr. Eng. SIMON AICHER
Forschungs- und Materialprüfungsanstalt Baden-Württemberg (FMPA), Germany

Monday, August 11, 14
From idea to the construction, who has been involved?

... COOKS

ROSA EMILIA ATEHORTÚA
Colombia

RUBY ESPERANZA FRANCO
Colombia

... PHOTOGRAPHY

LUIS GUILLERMO CAMARGO
Colombia
Grow a House

By Gunter Pauli
Illustrations Pamela Salazar O.

© 2012, GunPa Foundation
A macaw is looking for a place to live and flies by a house.

“Is it made of bamboo, steel, or cement?... It’s all the same. It’s a nice building,” the macaw says aloud.
“Yes, this is a beautiful house, but the farmer doesn’t like it,” responds a dog near the front door.

“What’s the reason for that? It is an elegant, solid, large house.”
“It’s made out of bamboo, and the owner hates bamboo.”

“Why?”

“Because he believes it is a symbol of poverty,” says the dog.
“If you look closely, this is a house anyone would feel lucky to live in. Look at that huge covered balcony on the second floor. This is a fine house. I would be happy to relax here and enjoy the view from the second floor,” says the macaw.
“I would be happy too, on the ground floor,” says the dog, “but the owner doesn’t want to live here. And to think that people from other countries just love these houses, for example, the Germans.”

“What do the Germans have to do with this? Do they have bamboo?” asks the macaw.

“No, they don’t. But they were so taken by the house when they saw it that they analyzed the bamboo and found it to be stronger than any other material, and they approved it as a construction material in their building codes.”
“So why doesn’t the farmer want to live here? It’s such a strong and flexible material that his house and his family will be protected even from earthquakes?”
“Perhaps he is afraid that termites will eat the house before his second baby is born,” says the dog.

“Of course, that could be a problem, termites love the bamboo’s starch.”

“No, actually that was a problem before. Now they’ve eliminated all the starch.”

“Using German chemicals?” asks the macaw.
“No, of course not. Chemicals are toxic. Now we treat the bamboo naturally, with bamboo smoke.”

“How can you use bamboo and burn it at the same time?”

“Since the building needs 6-meter poles, whatever is shorter is converted into charcoal for cooking. The smoke from that process is what treats the bamboo poles, which absorbs it completely, gaining protection from termites and moisture,” explains the dog.
“Wonderful! Now I’m convinced. With or without the farmer, I’m moving in here. It’s not only a safe and pretty house, it also has plenty of charcoal for cooking, and all without polluting!”

…and it has only just begun!…
Why Don’t They Like Me?

By Gunter Pauli
Illustrations Pamela Salazar O.

2012, GunPa Foundation
A bamboo is sad and crying. An Arboloco (a sunflower that looks like a tree) comes by and stops.

“What is wrong?” asks Mrs. Arboloco.

“No one wants me!” snivels the bamboo.
“I do not understand. All poor people around the world build houses with you,” comforts Mrs. Arboloco.

“No, as soon as they have money, they don’t want me anymore.”

“Why don’t they want you anymore?”
“People prefer steel and cement. They are ugly, they look dirty, and they are heavy.”

“It is not so bad. But you are right, when the earth shakes, falling concrete blocks can really hurt people.”

“No one will be hurt if their house is made of bamboo.”
“But if the people wants steel and cement, why don’t we build a house that uses the best of all three of you?”

“How do you dare? Cement can do nothing for me! It has taken my place,” screams the bamboo.
“Who said so? Here, I will make a little hole where two bamboo pieces join together and fill it with cement... I bet this will be stronger than steel.”

“I do not like that. It is going to hurt me.”

“Just do as I say, trust me, cement can be good, even for you.”

“How do you know?”
“I know by looking at the best of both of you.”

And so they make a joint. When the cement dried inside the bamboo, it was tested:

“Great. Thanks to a little bit of cement, I am now even stronger than cement alone.”
“Cement is good, but cement plus bamboo is best.”

“Perhaps I can help cement to be better another way!”
“Your fibers are so strong and long, it must be possible.”

“I could take the place of asbestos which makes people sick.”
“Cement needs you, you need cement, and together you have the power to be your best.”

“Now people want to have more bamboo, they plant me, they like me! Together we can make many people who have no home happy.”

...AND IT HAS ONLY JUST BEGUN!...