



AVEI School of Earthen Architecture

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SUMMARY

This paper describes a new school of earthen architecture which is in development in Auroville, India. The aims of this school include the construction of a new campus with earthen technologies, the introduction of one-year diploma programs at various levels, and the dissemination of scientific and technical knowledge aligned with the goals of the UNESCO Chair Earthen Architecture. Education will focus on earth as a building material, emphasizing sustainable, climate responsive design/construction, appropriate building technologies and natural resource management. The initiative aims to impact all levels of society through the co-education of building professionals. The article describes AVEI's current educational initiatives, the context and aims of the school, educational curricula, pedagogical philosophy, and overview of the campus design with projected building plans and associated earthen technologies.

1. INTRODUCTION& BACKGROUND

1.1 Principle Aims & Objectives

Since its inception, the Auroville Earth Institute (AVEI) has educated more than 11,600 people from 82 countries, including several generations of young Indian architects and engineers. AVEI is currently planning an initiative for the extension of its research and educational activities – the creation of a pioneering school of earthen architecture (Maïni & Davis 2014). The principle aims of the AVEI School of Earthen Architecture include: 1. The construction of a new campus with earthen technologies, 2. The introduction of one-year diploma programs in earthen construction to experts and laymen across all sectors of society (at post-graduate, post-secondary, vocational levels), and 3. The dissemination of scientific and technical knowledge on earthen architecture aligned with the goals of the UNESCO Chair Earthen Architecture (UNESCO, ENSAG 1998). The school is designed to welcome annually 80 permanent students for the one-year program and approximately 1,300 trainees for other short courses.

Education will focus on earth as a building material, emphasizing sustainable, climate responsive design/construction, appropriate building technologies and natural resource management. This initiative aims to impact all levels of society in India and abroad through the co-education of young building professionals (principally architects, engineers, masonry technicians and craftsmen). The goals are to equip underprivileged workers with the technical and entrepreneurial skills for impactful gain in the housing sector, to mobilize future generations of architects and engineers to improve affordable, sustainable, climate resilient housing, and to enable change in the building sector through the coordination and networking of specialists at all socio-economic levels.

1.2 Current Educational Initiatives

AVEI has 27 years of experience training experts and laymen alike in earthen construction. Current courses offered at AVEI include Production of Compressed Stabilised Earth Blocks (CSEB), Masonry with CSEB, Design with CSEB, Disaster Resistance with CSEB, Theory of Arches, Vaults & Domes, Masonry with Arches, Vaults & Domes, Ferrocement, CSEB for Disaster Resistance and Earth & Bamboo.

There has been a tremendous increase in the annual growth rate of training course participants, long term internship applicants and awareness courses for students and professionals. Yet the demand is now much greater than AVEI's current capacity, and additional faculty and facilities are required to meet this need.

1990: ~30 trainees	1999: ~60 trainees	2000: 282 trainees	2003: 451 trainees	2013: 829 trainees	2015: 1,065 trainees
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AVEI presently occupies ~900 m² of built-up premises on ~2,600 m² of land, including a conference room, practical exercises area, block yard, laboratory, workshop, storerooms and dormitories. These facilities can only accommodate 30 trainees, and the present location does not allow for any further growth. Accordingly, new premises and facilities are now being designed to meet the increasing demand for education in earthen architecture.

2. CONTEXT IN INDIA & GLOBAL APPLICABILITY

2.1 Earth Architecture in India

Nearly 30% of housing in India is built with earth: ~74 million houses with earthen walls out of a total housing stock of 249 million (Office of the Registrar and Census Commissioner 2001). India also has a diverse history of earthen architecture with various earth techniques, including cob, adobe, rammed earth, laterite block and wattle & daub (Pinto 2015) (Houben & Guillaud 1994) (India Environmental Portal 1992) (Correia et al 2013). This rich constructive culture has been dramatically declining in the last 50 years, and has been replaced by a mono-culture of country fired brick and concrete construction. A great many vernacular earth techniques in India have been lost without ever being recorded, even high profile heritage buildings are at risk (Petzet & Ziesemer 2008), and dedicated courses on masonry structures are no longer taught in engineering curricula (Menon & Murty 2014). Yet while the proliferation of concrete construction has thwarted the use of raw earth as a building material, particularly in Indian villages, earth remains one of the most competitive materials for sustainable construction. Today, earth is becoming indispensable as a low cost, low carbon and locally available building material, with an initial embodied energy and carbon footprint at least an order of magnitude less than conventional building materials like country fired bricks (Maïni & Thautam 2009). India has also been a pioneer in research for the modern earth technique of compressed stabilised earth block, and today there are a growing number of competent earth builders and building research centres (Golet al 1987) (Pinto, *ibid*).

2.2 Housing and Skill in India

Yet, for earth to be considered as a viable and productive alternative in India, skilled workers must be trained in much greater numbers. In India, there is no strong Technical & Vocational Education & Training (TVET) program (Mehrotra 2014), and formal technical education programs do not sufficiently cover construction skills (Chhabra Anand & Chariar 2016). Masons and construction workers rarely receive formal training, and virtually the only existing training programs focus exclusively on concrete and fired brick. Most construction workers are trained on the job, and their skills are generally quite poor. Among 31 million workers in the construction sector in India, 82.45% are considered unskilled by the government (Chhabra Anand, *ibid*) (Planning Commission 2007). Authorities have even acknowledged that the terrible losses caused by the Gujarat

earthquake of 2001 were mostly caused by very poor quality buildings built without competent labour (GSDMA 2006). Prime Minister Narendra Modi has emphatically stated, “If we have to promote the development of our country, then our mission has to be skill development and skilled India. Let’s make India the skill capital of the world.” (Modi 2015) (Gol). Accordingly, it seems evident that masons and construction trade workers should be formally trained and certified by competent institutions to meet government targets for the growth rate of the housing sector (Gol).

2.3 Demand for Education in Earthen Architecture

Currently there are only a few institutions in the world which train engineers and architects in earthen architecture. Yet training for masons and technicians in earth is largely forgotten. Who can pay for their education? How can programs be financed which sponsor masons for a full 1-year fellowship of vocational training program? How can masons develop sustainable livelihoods when their training is complete? The AVEI School’s goal to finance masons’ education has been verified through operational sustainability analyses. AVEI is committed to developing this program for masons with the conviction that its existence will impact the Indian housing market and provoke government officials to find viable solutions to subsidize national training for skilled construction workers.

The demand is growing, in India and abroad, for a comprehensive and holistic approach to the study of earthen architecture, which addresses sustainable design and construction practice, climate responsive design and natural resource management. In the last 15 years, young generations of Indian architects have consistently demonstrated a desire to design and build with earth; however, few initiatives succeed at a larger scale because no organization in the country is training earthen masons. AVEI trainees – presently mainly architects, engineers, self-builders and students – have developed numerous marketable skills. However, they have difficulty implementing their skills, because they cannot find skilled technicians and masons to build their projects. Effective, collaborative networks for trained individuals at all professional levels do not exist. Therefore the greatest obstacle to wide scale implementation of contemporary earthen techniques has been largely a matter of awareness and coordinated skill. The operational aim of this initiative is to train and link large numbers of skilled professionals for sustainable start-up ventures in national and global housing markets. For this, it is necessary to educate and train networked teams of architects, engineers, technicians and masons, in order to provide them with the means to work as entrepreneurs in their area of expertise, to provide a common knowledge base and to facilitate communication across all professional levels.

3. EDUCATIONAL PROGRAMS, CURRICULA & PEDAGOGICAL PHILOSOPHY

3.1 Educational Programs of the AVEI School

The following educational programs will be offered at the new AVEI School:

- *Awareness courses* will continue to be offered in greater numbers for all skill levels.
- *Short Term Intensive Courses* of one and two weeks’ duration will continue to be conducted for varied skill levels. Certificates are issued at the end of each workshop in accordance with AVEI’s UNESCO chair designation. The present structure of these workshops will be extended, allowing for a greater capacity of participants and a growing range of courses.

- *Long-term internships* will continue to be conducted for students of architecture and engineering. The primary target group are students fulfilling academic internship requirements, who work in the architecture department on project design development, in the research department on embodied energy analysis of buildings, in the laboratory for research on material technologies and building systems, or in the field on construction projects.

- *PhD & Post-doc researchers* will continue as at present.

- *One Year Degree/ Diploma Programs* for students and professional have been organised at three levels as the core development of the AVEI School. The curricula for all three programs will be carefully coordinated, to emphasize a common knowledge base for architects, engineers, masonry technicians and craftsmen. Teaching Modules will include: A. History & Conservation (4 credits); B. Techniques Theory (9 credits); C. Techniques Practice (12 credits); D. Sustainability (5 credits); E. Architectural Project & Thesis (20 credits); F. Practical Site Management (10 credits); and G. Exams. The following programs will be offered:

Post-Graduate Course (for Architects & Engineers): The curriculum for this course, modelled on CRATERRE's DSA (CRATERRE-ENSAG 2016), will emphasize design practice and related theory, with case studies and an independent design-research project. Students will also work on practical, hands-on exercises related to materials and will have a short-term residency period on site. This program will target university level graduates of architecture and engineering (B.Arch, M.Arch, B.Eng, M.Eng) from India and abroad.

Post-secondary Course (for Masonry Technicians): The curriculum for this course will be similar to the curriculum for the Post-graduate course, with notable differences emphasizing earth techniques best suited for the climates in India. The curriculum and student design projects will focus on the translation between design, engineering and construction through technical design, site supervision and enterprise management. There will be a medium term residency for on-site training. This course will target graduates of Indian secondary technical track schools (or individuals with a secondary level education equivalent to the Indian 10th standard).

Vocational Course (for Masonry Craftsmen): The curriculum for this course will focus on topics pertaining to masonry craftsmanship, with additional topics selected according to the students' level of knowledge and skill (e.g. drafting, material and cost estimation, accounting, micro-financing and entrepreneurship, etc.). The teaching methodology for this program will be predominantly hands-on and practice-oriented, with a long-term vocational residency of on-site training. This program will target underprivileged building craftsmen and unskilled workers with a strong motivation to invest in professional education, and will be subsidized to answer to an acute need for more skilled and resource-conscious building professionals in India.

AVEI proposes to grant the following diplomas as a formal sanction of knowledge:

- Post-graduate degree/ diploma "Earthen Architecture" to architects and engineers
- Post-secondary diploma "Technician of Earthen Construction" to masonry technicians
- Vocational diploma "Master Earth Mason" to masonry craftsmen

3.2 Pedagogical Philosophy & Core Competencies

The curricula of the AVEI School will reinforce co-educational principles across all socio-economic levels, to stimulate knowledge exchange, professional collaboration and

entrepreneurship opportunities for a network of new leaders and decision makers in sustainable practice. Education will focus on earth as a building material, with core competency topics including modern and traditional earthen construction technologies, vernacular construction methods, cost-effective / low-carbon appropriate building technologies, climate appropriate and ecologically sensitive design / development / construction practices, natural resource management, circular ecology principles and sustainable livelihoods. Coordinated management of natural and human resources (i.e. consideration for both local ecological and livelihood needs) is considered as the institution's principle target for sustainable development.

Theoretical courses will be balanced with active pedagogy (i.e. practical exercises) to provide hands-on and on-site training at all levels, to develop quality workmanship skills and reverence for craft. Teaching methodologies will build upon students' soft skill capacities to instruct others and serve as trainers/supervisors, for the promotion of secure training multiplication. Special attention will also be given to fostering basic entrepreneurial skills to encourage the establishment of small scale production units for employment and economic gain in rural areas.

The school's pedagogical philosophy goes beyond merely technical, instructive education, and aims for creative and transversal education for makers (Doat 2014) (Bayl-Smith 2011). Arts and culture components will offer students the opportunity to participate in the construction of traditional Indian building typologies and to work with heritage construction techniques and materials. Innovative didactic methods will be employed to synthesize low-tech and high-tech approaches (e.g. with digital design tools, computation and 3D software). The school intends to foment a culture of design and creative problem-solving for real-world challenges. Student theses will ideally aim at developing useful, endemic solutions specific to students' home contexts – making the school a design-build laboratory which may further applied research in the field.

4. GLOBAL ALLIANCES & PARTNERED ACADEMIC RESEARCH INSTITUTIONS

4.1 Accreditation & Endorsements

AVEI's qualifications to teach one-year degree programs are outlined by its UNESCO chair designation. Accreditation within the Indian academic system is forthcoming. The AVEI School initiative has been endorsed by a number of prominent UNESCO representatives, government leaders, leading academicians and respected practitioners.

4.2 Institutional Partnerships

AVEI is the Representative for Asia for the UNESCO Chair "Earthen Architecture, Constructive Cultures and Sustainable Development". The main objectives of the chair are to accelerate research and development worldwide, including the dissemination of scientific and technical know-how on earthen architecture amongst the higher education institutions in the following three domains: environment and heritage, human settlements and economy and production.

An academic partnership agreement has been established with CRAterre-ENSAG (The International Centre on Earthen Architecture, Grenoble, France) for AVEI to offer long-term training courses to CRAterre post-master's students. AVEI also frequently partners with

academic institutions for collaborative scientific research ,including the following from 2012-2015:IIT Madras, Department of Civil Engineering, India; Swiss Federal Institute of Technology (ETH Zürich), Department of Architecture, Switzerland; Nottingham University Centre for Geomechanics, Faculty of Engineering, UK; Ecole Polytechnique d'Architecture et d'Urbanism, Algeria; Ecole Nationale Supérieure d'Architecture de Grenoble, France; Massachusetts Institute of Technology (MIT), USA.

AVEI is also part of a network of institutions at the local, state and national level which aim collectively to impact sustainable livelihood development in India. Among them is the Tamil Nadu Sustainable Livelihood Institute (SLI), for which AVEI is participating to deliver equitable and environmentally conscious livelihood training for the state of Tamil Nadu.This program is envisioned to act as a feeder program for the AVEI School, while impacting policy decisions related to appropriate resource management.

5. CAMPUS PLAN

The AVEI School campus (Fig. 1) has been designed to incorporate a wide range of vernacular techniques (e.g. adobe, cob, wattle & daub, raw rammed earth) and modern stabilized earth techniques developed at AVEI (e.g. CSEB, poured earth concrete, rammed earth walls and foundations, composite earth columns, beams and ring-beams, CSEB vaulting, interlocking blocks for disaster resistance, thermocrete insulation, stabilized earth plaster and waterproofing, stabilized earth roads).

With a gross floor area of 9,644 m², the buildings include a Conference hall (Fig. 2) (earthen hyperbolic paraboloid – “hypar”built with CSEB and poured earth concretewalls), Administration hall (Fig. 3) (Catalan conical vaults and staircase with CSEB), Exhibition hall (contemporary and vernacular earthen techniques), Underground parking (earth berm vault with rammed earth and CSEB), Masonry hall and laboratories (Fig. 4 & Fig. 5) (24m span earthen vault built with CSEB without formwork and with interlocking CSEB walls), Student Boarding (B+4 multi-story earthen construction), Classrooms (segmental dome with CSEB) and Dining hall (freeform vaulting with CSEB and poured earth concrete walls).

The campus will make maximum use of local materials (soil excavated on-site) to minimize and carefully record its initial embodied energy. In the principle of the circular ecology, soil excavations will be transformed into ecological landscape features (e.g. for rainwater percolation and catchment systems, earth tunnels, basement floors, decentralized wastewater treatment systems, etc.) (Fig. 6). Climatically appropriate, passive design strategies will aim to optimize natural lighting and ventilation for greatest energy efficiency and low operating energy.

The construction of the AVEI School is envisioned to impact the acceptance of earthen building, locally and at large, by pushing the material to new limits. With sensitive design for the cultural context, climate, local ecology and site, the campus will be a demonstration of best-practice natural resource management and sustainable land management practices with earth as a building material. The creation of this unique school of earthen architecture will give young generations of architects, engineers and builders the tools to develop and manifest innovative solutions in earthen construction.



Fig. 1: Campus plan & building features



Fig. 2: AVEI campus with masonry hall (24m span vault) & conference hall (hyper)



Fig. 3: Entrance of the administration



Fig. 4: Interior View of Masonry Hall



Fig. 5: Training Course for Local Women

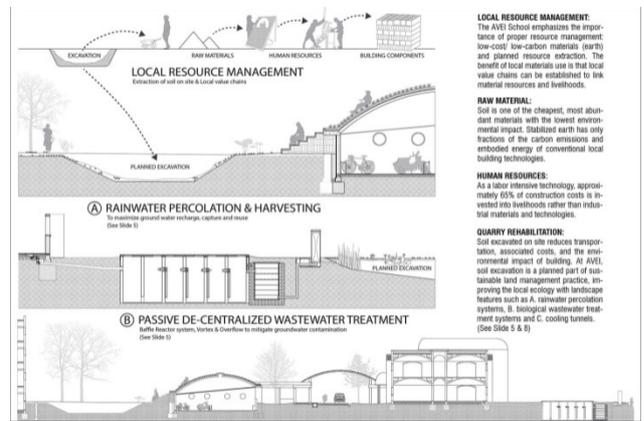


Fig. 6: Sustainable land management practices

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BRIEF BIOGRAPHICAL NOTE

Lara Davis is an architect and co-director of AVEI. She has 16 years of experience in masonry research, design and construction, and specializes in the structural design and construction of earthen vaulting. She holds an M.Arch from MIT, with notable research at the MIT Masonry Research group, ILEK/Stuttgart and BRG/ETH Zürich.

Satprem Maïni is a French postgraduate architect in earth architecture. He is the director of AVEI. He has worked in 36 countries and with his team has trained over 11,600 people from 82 countries on earth architecture. Satprem is the Representative for Asia of the UNESCO Chair "Earthen Architecture". He has been granted 13 awards.