SOLAR SCHOOL IN THE VILLAGE OF KARGYAK

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Summary

The project Solar School for Kargyak aims at providing education for children in the remote village situated 4200m above sea level in Himalayas. As part of this project, a sustainable, low-energy building of the school was designed and built using exclusively only local natural materials. All the construction work was planned with the local environment and ecology in mind and no machinery was used. Only local people and the aid of domestic animals covered all the work. The school was handed over to the villagers of Kargyak in September 2008. Last year the school celebrated its first year in successful operation, including the tough winter season when temperatures drop down to –40C.

Keywords: passive solar, zero carbon, Himalaya school, solar school, adobe, Surya

Fig. 1 School building

1 The Aims of the Project

The first ideas about the Project surfaced as a reaction to the high level of illiteracy in the valley of Lung Nag, particularly in the remote village of Kargyak in the Himalayan Mountains, the Ladak and Zanskar District in Jammu and Kashmir, India. There had never been neither a school nor any systematic education programme for the villagers before our Solar School Project, and the illiteracy level was reaching the alarming 90% of the inhabitants. The target group for our Project were the children in Kargyak; however, the school serves a wider catchment and welcomes children from the surrounding villages and adults, too. Until recently, when parents wanted to secure education for their children, they had to send them to a boarding school in remote towns. This meant that children could only come back home for school holidays or not at all. Very often, after finishing the

education, they would not return back home, because they would struggle finding appropriate job opportunities there. This caused the family relations be disrupted and very often even ruined. Moreover, the villagers who were educated, were discharged from the village to the towns and only people with little education stayed.

Recently, the village found itself under a new pressure. The Indian government has revealed plans to build a main road through the area of the village within next 10 years and so establish an important link over the mountains. It is crucial that the villagers in Kargyak have at least basic education in order to withstand the changes associated with such development and future aspects of the new world that this road will bring. Opening a school in the village enables the local children to gain education while staying in contact with their families and culture, and to find more qualified jobs in the area.

The idea of the Solar School was first outlined as part of Jan Tilinger's thesis upon the completion of his MEng. He then continued working on this during his PhD studies at the Faculty of Civil Engineering at Czech Technical University in Prague, the Czech Republic. His work included a detailed design plan of the school and detailed technical construction documentation followed by realisation of the project in Kargyak. Jan Tilinger supervised the whole realisation of the project in Kargyak to ensure that all key elements were carried out satisfactorily.

The Village of Kargyak is situated in a rain shadow in the area of a mountainous desert at the altitude of 4200m above sea level. The village lays 3 days' walk away from the nearest road. Most of the villagers are dependant on self-grown crops and vegetables, and on keeping sheep and yaks. Families are usually energetically and economically self-sustainable, but the vegetation season is very short (maximum 5 months). Therefore, children have to help their parents in the fields during the summer season in order to ensure that enough food is produced to survive the off-season time. This affects their education programme and children can only go to school in winter time. This is why a school that can be operational during the tough winter months is so important.

Further aims of the project included verification of new approaches to the construction of buildings in the extreme high-altitude conditions in the mountains, and passing our experience onto the local people in order for them to be able to carry out similar projects in the future. Therefore we aimed at using exclusively only local materials, understanding and respecting the local culture, traditions and traditional architecture, while ensuring high comfort and low energy input levels.

The project also aimed at gaining experience with management and maintenance of the school. We expect that within 5 years, the local people will be able to run the school without any external help. Our project has also continuously contributed to promotion of construction of more buildings of similar kind in the area. The experience and knowledge that the local inhabitants attained at Solar School will also enable them to better understand the great natural, cultural and traditional values, as well as their efficient use in everyday life.

The school is also used as a community centre and a hall for meetings for the local committee.

2 Solar Greenhouse

The construction of the school was preceded by investigations of the local climatic conditions, which confirmed that Kargyak is a suitable location for the use of solar energy.

In autumn 2006, a greenhouse was built in order to test how the local villagers would be able to use it and whether there would be enough capacity from solar energy for heating. Last but not least, this test was also to prove whether the local material used for its construction and the proposed construction techniques were suitable. Another reason for building the greenhouse was to enable growing fresh vegetables in winter time.

The test showed that the temperatures recorded in the greenhouse were acceptable and therefore the construction technique and material were sufficient even during temperatures deep below zero. For example, during outdoor temperature at –27C, the temperature in the greenhouse did not drop below –2C and during even lower outdoor temperatures, the greenhouse temperature stayed at zero. The greenhouse has been working continuously without any problem since its construction.

3 Architectural and structural design of the school

The school was designed as an energetically independent building, i.e. a building that needs minimum energy inputs resourced from within, without having to use any external sources of energy.

The school was designed as a ground-floor building with a cellar. There are 3 classrooms, a corridor, a hall and sanitary facilities. The heating system was based on the utilisation of solar radiation, air circulation in the indoor environment and high level of heat accumulation by the building itself.

The structure of the building was designed so that it can maximize the use of solar energy. It is particularly the location of the village at such a high altitude that enables the school to use the solar energy and create comfortable indoor environment for the classes. The air is incredibly clean in Kargyak and the long-term average number of sunshine days in a year exceeds 300.

Fig. 2 Corridor of new school

The school is heated by solar radiation coming through the south-facing wall made of glass. Further, the indoor air circulation is used to support the balanced indoor temperature – the temperature can be regulated by air channels in the building. The whole system of

heating and ventilation does not have any active air-conditioning units or any other technical equipment. The regulation is achieved only by gravity circulation.

The solar energy is also used to provide electricity for lighting (12 and 230 V) and also for a number of appliances such as computers, etc. The solar panels on the roof of the school generate very high power of 800 W. This is enough to cover all the electricity needs of the school. The only disadvantage of this system found during the initial period was insufficient recharge of accumulators during the night and during occasional adverse meteorological conditions with lack of direct sunlight. For these reasons, a small wind power station was installed at the school in summer 2009, which can generate power of 400 W. This ensures that the energetic system is fully operational even during the adverse conditions.

The core of the school building consists of two blocks. The south-facing wall was skewed and 86% of it was made of glass. The bottom of the building was based on stonewalls. The vertical skeleton was made of a peripheral stonewall, the interior's skeleton was reduced to vertical wooden pillars. Cross buntons were made of unfired bricks.

Fig. 3 Entrance interior

The siding of the building was made of stonewall and the inner layer of unfired bricks. An insulation layer form straw was placed in the space between these two layers.

The roof was designed as a modified traditional roof construction. The roof frame was made from poplar and willow wood and the roof cover from wicker and straw. Hydro isolation was ensured by a layer of clay, protected from drying out by a layer of soil.

The stone for the walls came directly from the construction site, the unfired bricks (1 piece has about 25kg) were made in a nearby clay mine using a method that best suited the local conditions. Prior to the production of these bricks, a thorough investigation of the local materials (particularly clay locations), their texture and constitution, and testing of their mechanical qualities were carried out in the laboratories of the Czech Technical Univeristy in Prague. The bricks were transported to the construction site by horses, donkeys and yaks. Most of the construction material was available directly in the village (such as stone, straw or clay), or its vicinity (the maximum distance from the site was less

than 1km). Other material such as wood and glass was brought over the frozen river using horses or human labour during the winter. This way the ceiling beams were transported over a distance of about 50km. The construction was entirely manual without any use of any heavy machinery.

Fig. 4 Entrance outside

4 Construction of the School

In summer 2006, the organisation Surya, which was founded for the purpose of realisation of the Solar School Project, agreed with the Kargyak villagers to build the school. In the same year, a provisional education program was launched in rented rooms. The program has been running continuously since spring 2007.

In February 2007, the ceiling beams were transported over the frozen river from the village of Icar. The functionality of the greenhouse was tested, the temperature data recorded and analysed. This helped estimate the number of children that would be possible to accept at the school.

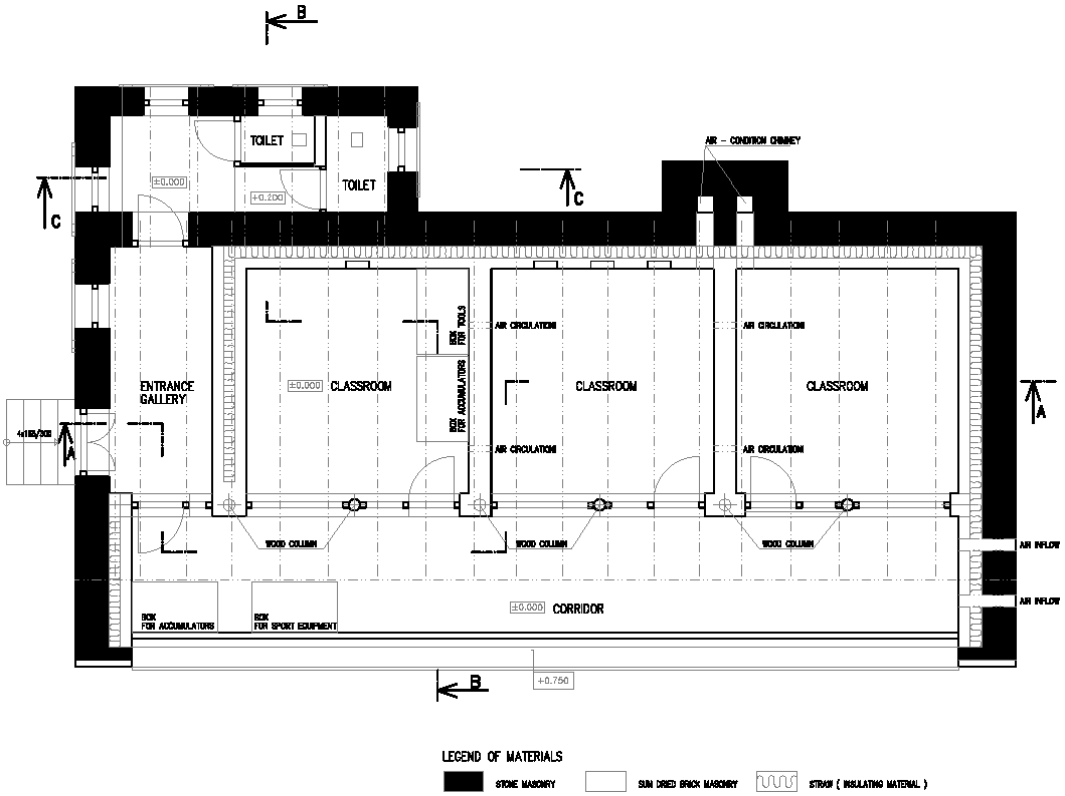


Fig. 5 florplan

The transportation of the construction material and supplies for workers in the village continued during spring 2007. The villagers had their specific roles in the project and were formally contracted to carry out the work. The construction work started with earth works on the selected site above the village. In spring and during the summer of 2007, the manual work continued (in the scale of 1200m^3 of soil) and the foundations of the school were prepared. Further, three 120m long supporting walls were built from stone. Optimised traditional methods were used to produce 1000 pieces of unfired bricks (using traditional forms with dimensions of 20x20x40cm). These bricks were then transported to the construction site in autumn 2007.

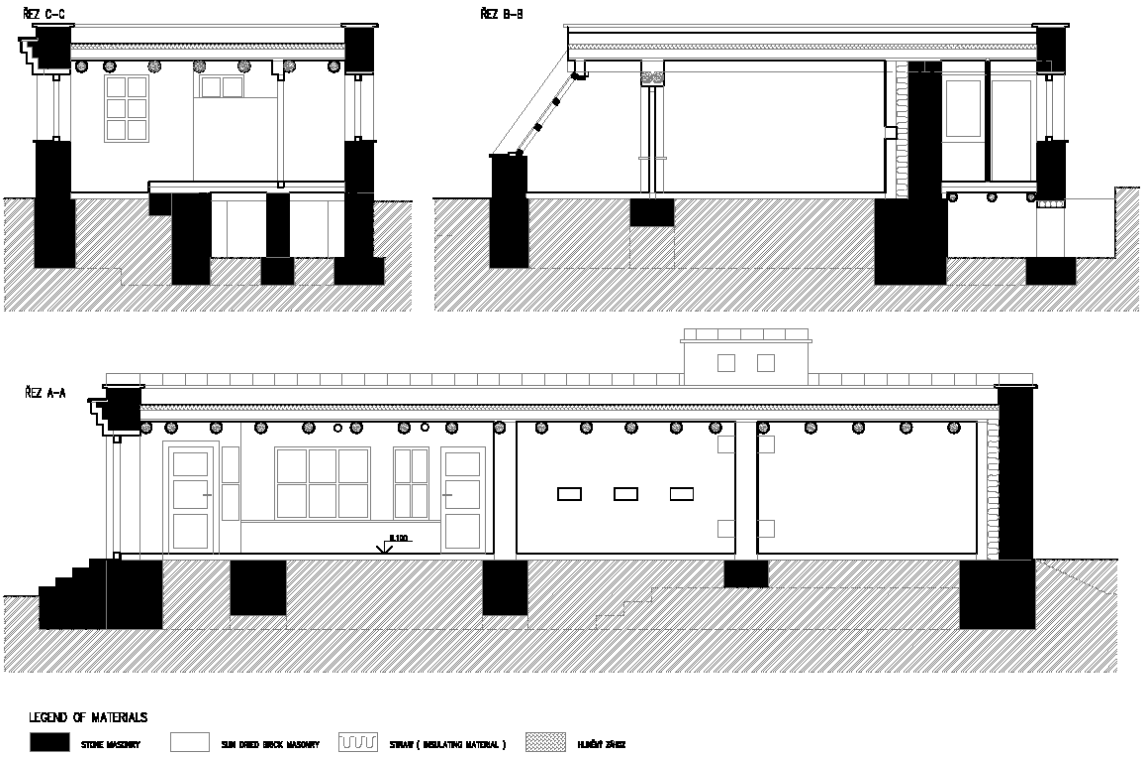


Fig. 6 sections

The construction work continued in 2008. The work was resumed in June and continued till the end of September. During this period, there were 29 workers from Nepal and 9 from India. Apart from these, there were about 80 volunteers not only from the Czech Republic, but also from other countries (e.g. Switzerland, Poland, France and the USA), who came to help with the project during the last 2 years. The local inhabitants worked on preparation of the building material from local sources, they made the bricks, prepared and transported the stone for paving. Further, they ensured supply of other material that was needed during the construction and could be sourced locally.

The experiences attained during the construction work of the greenhouse were an invaluable source of skills for construction of the school. The school was finished in September 2008 and has been fully functional without any problems, even during the winter time, since then. Even during freezing outdoor temperatures, the classrooms have about 12 degrees in the morning and comfortable 18 – 23 degrees during the day.

5 Conclusion

The successful project of the Solar School in Kargyak demonstrates that to build a sustainable, ecological and energetically independent building in the mountainous location such as Himalayas is feasible and realistic. The construction used traditional local material and technology, with due respect to the traditional architecture.

The solar energy satisfactorily covers the demands on heating and electricity supply for the school. In case of extreme climatic conditions, the demand is additionally covered by a newly installed wind power station, or the school can use a metal stove for burning dried excrements of yaks.

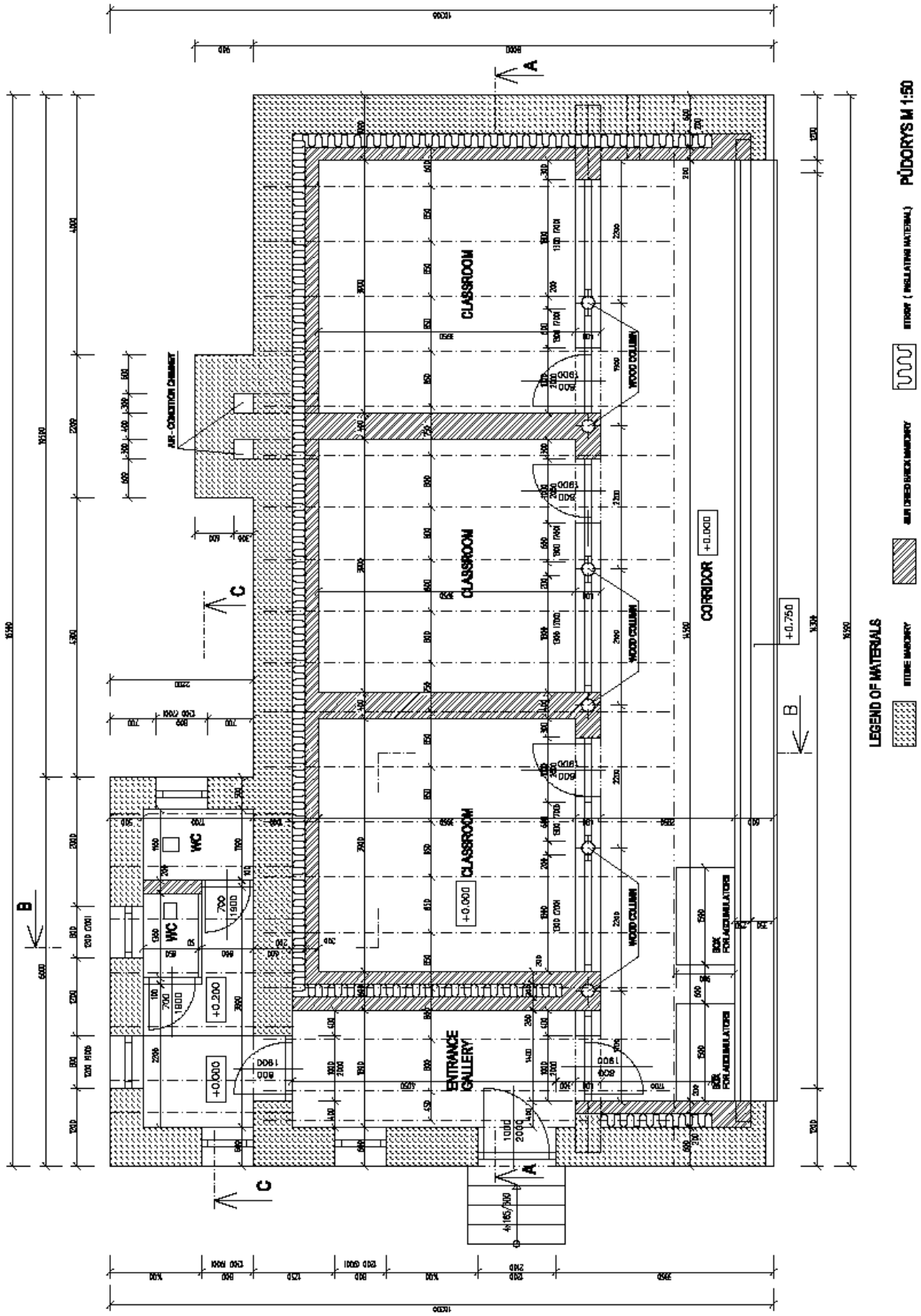
The indoor environment of the school is remarkably better than in the traditional buildings of the local people, who only use metal stove to heat up their houses and to cook. Insufficient aeration of their houses and the smoke from the stove create rather unhealthy indoor conditions and besides, they are not environmentally friendly.

We hope that the new school will be a prototype for other similar buildings not only in the area of Kargyak, but in any other places where enough sunshine days in a year can ensure sufficient supply of solar energy. Other types of buildings can use this technology, too, for example residential houses. The materials used for the Solar School can be changed for other types depending on their availability in the area and suitability of the material.

The skills and experience gained during the construction of the school are valuable assets to the villagers. They will be able to apply them when reconstructing the building, or when building new houses. Passing on our knowledge and experience and hence ensuring better future for the local people was one of the most important parts of the project. By the way, the solar greenhouse has already been used as a model for similar buildings in several neighbouring villages.

The Civil Association Surya financed the whole design and construction of the school only with the financial aid from donations and sponsors. This financial aid now also helps Surya run and manage the school, cover investments in its equipment, school things and teaching material, and wages for local and Czech teachers.

The Solar School in Kargyak is currently the only school in the region that offers education all the year around without any problem. The school is very intensively used not only for education of children, but it also offers basic education for adults in Kargyak and its wide surroundings.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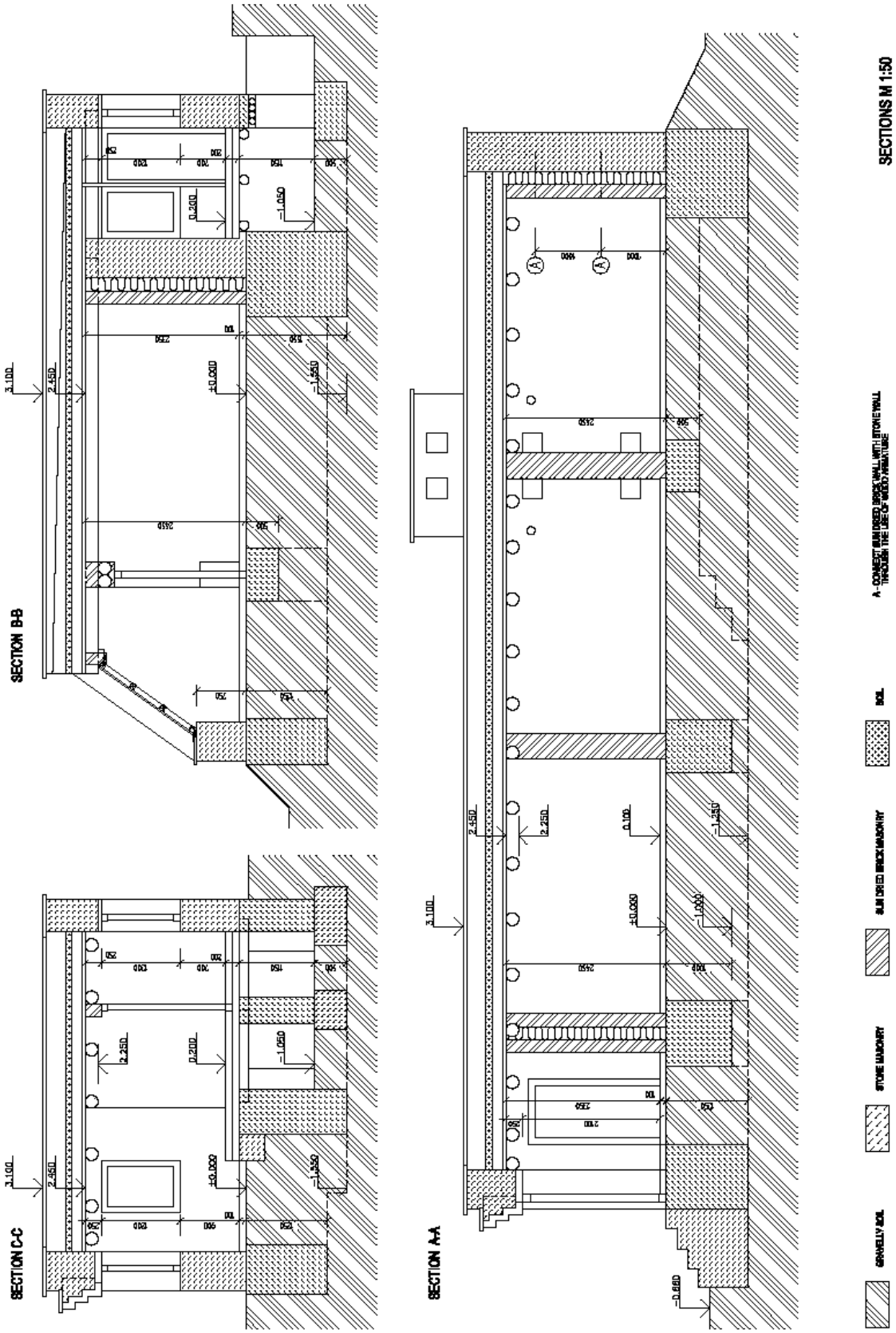
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