The challenges of congestion and aridity are perennial issues for cities in Egypt, in which they are rapidly worsening. In order to lessen the chances of rising populations densities in urban regions, constructing buildings in arid areas using a suggested method which is using alternative construction materials to form a beam to be used in constructing slabs for single storey buildings. Alternative building materials are required in building to achieve low cost, the ease of construction, economic and environmental criteria. Wood is the chosen alternative of steel in this project. Wood principal advantages over the other common structural materials are: 1- Its economy 2- Its appearance 3- Its ease of working and reworking. Other advantages are better durability ,high strength to weight ratio and thermal insulating properties. Wood structures also offer less cost in construction rather than steel reinforced concrete structures. (Stalnaker & Harris, 1989).Two types of wood are chosen in this project to achieve the cost and quality criteria. Oak wood is the used material for construction for its special characteristics including strength, the coefficient of variation of the bending strength of oak is around 15 %. It's important to note that while steel is over three times as strong as oak, it is ten times heavier. Thus, the strength/weight ratio of clear dry oak is much superior to steel, so earlier it was for this reason a preferable building material than steel. Another criterion is that oak is one of the most durable of the temperate hardwoods, and its heartwood can be used with confidence for both internal and external structures (Ross, Mettem, & Holloway, 2007) .Beech wood is the other used type for it as it is affordable , available and provides major advantages including Hardness and High abrasion resistance to moisture. Thus, the strength/weight ratio of clear dry oak is much superior to steel, so earlier it was for this reason a preferable building material than steel. Another criterion is that oak is one of the most durable of the temperate hardwoods, and its heartwood can be used with confidence for both internal and external structures. Beech wood is the other used type for it as it is affordable, available and provides major advantages including Hardness and High abrasion resistance to moisture. Then, the T-shape was chosen for the constructed beam. T-section beam is one of the most common shapes used in slab construction in different types of buildings. The slab forms the beam's flange while the part of the beam projecting below the slab forms the web. Its flange provides additional compression area having a thickness not less than one half of its web to achieve the flange, if the flange is very wide, the compressive stresses are at a maximum value at points adjacent to the beam and decrease approximately in a parabolic form to almost 0 at a distance x from the face of the beam. Stresses also vary vertically from a maximum at the top fibers of the flange to a minimum at the lower fibers of the flange. This variation depends on the position of the neutral axis and the change from elastic to inelastic deformation of the flange along its vertical axis. (Sikora, Gaffová, Rajnoha, Šatanová, & Kminiak, 2017) .In the first attempt, the T-shape is formed by pieces of wood cut in puzzle shape with dimensions 3*2.5*.6 cm as shown in the Sketch up model studied in CS.1.01 shown in the fig8. (fig8) The sharp edges of the puzzle shape reduce the used amount of glue and helped pieces hold each other increase the maximum load. The maximum amount of glue was calculated by finding the volume of the beam and dividing it by 5 as the specifies amount of glue according to the design requirements should not exceed 20% using the formula: Volume = Length × Width × Height = 2.5×50× (2.5+1.80) = 537.5 cm^3 then dividing it by 5 we get 107.5 cm^3. The actual used percentage was 11% of the volume= 59.125 cm^3.

The mass of the beam was measured using a sensitive scale (fig9), the measuring was (fig9) repeated 3 times and the average was taken to find the most accurate measure as accuracy and Precision were studied in Ch.1.01. The pieces were connected to form three 50 cm rows, two of them glued together face to face to form the web, and the other row was glued perpendicularly to them to form the flange. The beam was tested by a three-point bending test; The beam was placed on two tables with3 cm of the beam on each side. The beam in this state is statically determinate (Static equilibrium as the ∑F= 0 studied in Ph.1.02), which means that the equilibrium equations are sufficient to determine the forces and stresses in a structure. These equations are: ∑Fy= 0 (shear -vertical- force), ∑Fx=0 (Normal force), ∑M=0 (Bending Moment). After adding a 5N vertical load, the beam turns statically indeterminate as the top of the beam starts to be compressive. The bottom started to be tensile so that the beam deflected by 1mm increasing while adding the loads gradually. The loads were added in the center of mass (concentrated load) to distribute the reaction force equally on the terminal sides as studied in (Ph.1.05). the deflection was measured accurately by the ruler and the accuracy rules of reding have been followed as studied in ph.1.01. the deflection was analyzed after finishing the test as shown in the graph below using the graphs studied in MA.1.02 shown in figure 10: (fig10) It was discovered that the reason behind the failure is the flange having thickness less than one half the thickness of the web and the applied glue wasn't enough to make the pieces be tied strongly .so, The beam was modified by adding another layer on the top of the flange to increase its thickness to 1.8 cm and that made the material concentrated far from the neutral axis so the moment of inertia was increased and bending reissuance was increased as a result. The type of the glue was changed as it was a reason as the tension happened in the bottom of the beam caused the units to be separate from each other because of the glue. The same testing steps was applied, that time the design requirements was achieved by the beam carrying 6500 g as maximum load with deflection 7.5 mm at 5000 g the observed deflection is represented in the graph shown in figure 11: (fig11) The load to weight ratio was calculated by dividing the maximum load the beam could carry by the mass of the beam using the formula: □□□□□□□□ □□□□ □□ □□□ □□□□ □□□□ □□ □□□ □□□□ = 6500 281.85 =23. Maximum Stress was also calculated using the formula: □□□ □□□□□□□ = □□□□□□□□ □□□□ □□□□□□□ □□□□ = (.5□9.8) (.025□.5) = 63.7 0.0125 = 5096 □/□2. The surface area was calculated following the formula of area: Length × width studied in MA.1.05. The Prototype has shown its effectiveness in solving the problems according to the criteria of cost, time, and quality and the design requirements of carrying the load of 50N and not deflecting more than 10mm at that load, which means finding a qualified major component of structure to construct safe single storey buildings that will be built in arid areas and solve the problems of urban congestion. Conclusion After this prototype was constructed, some major points were inferred from the results and their analysis, including: - Oak wood and Beech wood are suitable alternative building materials as they achieve the solution requirements of low cost and high quality. - The T- shape is chosen for its mechanical properties and the stress it can bear. - The capacity of the beam was affected by the thickness of the flange as it is supposed to be one half the thickness of the web. - The type of the glue and the duration of letting it dry are major factors that affect the capacity of the beam. - The constructed beam follows a puzzled pieces method connected using glue to hold the pieces together and that helped with producing better results. - This project has proved

its capability of solving the problem after achieving the design requirements and carrying a load of 65N with deflection of 7.5mm. Recommendation In order to get better results while this solution is applied by researchers and engineers, here are some points that could be taken in consideration in future research: –The type of glue could be changed to produce better results. The best type to be used is Gorilla glue, which is imported from the USA, and it proved its effectiveness in joining two types of wood like oak and beech. –It's recommended that the puzzles have a slot to pass a tiny supporting column to join the web and the flange together to increase the maximum load and the load to weight ratio. –The drying time of the glue is suggested to be increased to let the pieces be more cohesive and increase the capacity of the beam to reach the desired results. Beech wood is not durable to change in humidity, so this problem could be solved by using mineral oils that could be used to isolate wood from moisture, but the cost will .exceed the allowed budget