This experiment was designed to investigate the flexural and shear failures, along with load vs. deflection and moment vs. curvature relations for a simply supported beam with a vertical point load applied at its midpoint. Four specimens were tested with varying compressive and tensile reinforcement, reinforcement cover, and varying stirrups spacing so that the physical outcomes of each specimen could be compared. Failure predictions of each specimen using ACI-318 provisions were made, and then compared to experimental results so that ACI code could be analyzed and evaluated.

The purpose of this experiment was to investigate beam behavior when undergoing vertical loading. The specific requirements and comparisons in this experiment are summarized as follows:

- Based on nominal material strengths of $f_y = 60$ksi and $f'c = 4$ksi compute the moment-curvature relationship and deflection at: prior to cracking, just after cracking, yielding, and extreme fiber strains of $0.005, 0.0065, 0.007, 0.01$.
- Plot moment vs. curvature based on nominal and actual material strengths against experimentally obtained curve on the same graph.
- Plot load vs. displacement based on nominal and actual material strengths against experimentally obtained curve.
- Calculate the deflection at mid-span using the effective inertia moment detailed in ACI-318-05 Section 9.2.3.
- Calculate shear strength (capacity) of specimen using ACI 318-05.
- Plot the experimental and theoretical load vs. displacement against shear capacity.

The test specimen was a simply supported beam with a load applied upward at the mid-span and was increased until failure as shown in figure 1. The experiment was designed to examine flexural and shear strength failures, as well as allow for comparisons between analytical and experimental moment - curvature load - deflection relations. The beam was fixed to end supports, which allow for rotation caused during deflection therefore inhibiting unintended moment creation within the beam as shown in figure 2. Reinforcing details are shown in figure 3, and the beam cross section is showing in figure 4.

The beam specimen was constructed using #4(Grade 40) and #5(Grade 60) longitudinal reinforcements. The rebars were used to produce a greater flexural strength. The concrete used was consisted of a 5200psi mixed material with 3/8 in. maximum aggregate and a 4 in. slump.

The test specimen instrumentation consisted of two metal supports at both ends; these supports are fixed in the ground below and allow for rotation at both ends of the beam. An LVDT placed above the beam at the mid-point to measure the beam's deflection due to the load, two LVDT's attached to the side of the beam, at top and bottom, these sensors measure the amount of strain on the beam at different loads, and are later used to find the curvature. Manual air pump, air pressure Jack, and data acquisition system including voltmeters and computer are other equipments used in the test. Some details of instrumentation are given in figure 6 & 7, whereas equation relationships used to derive Moment-curvature and deflections are shown in figure 11.

The beam was subjected to a point load applied upward through the midpoint of the specimen, and the load was increased until failure. The behavior of the beam was compared with the analytical predictions. The deflections of the horizontal sensors divided by the distance between the two resulted in finding the curvature. The experimental moment was found using: $M=PL/4$ at the center of the beam. The moment-curvature diagram obtained from the test was then compared with the analytical values (Fig. 14&16), which were calculated using the stress strain diagram with a linear approximation of the concrete compressive force for the points before yield, and an iterative algorithm for the points after yield (Fig.10). The experimental load-displacement diagram was plotted using the vertical displacement and the corresponding load, and then was compared with the analytical diagram (Fig. 14&16), which was computed using the moment – area approach based on the calculated uncracked and cracked beam and column stiffness values determined from the moment curvature diagrams. The nominal shear strength of the joint was found by using ACI 318-05 Eq. 11-3. If there are not enough stirrups in the beam, the shear force applied to the beam might exceed the shear strength of the specimen and which would result into the failure of the beam. The occurrence of this phenomenon could be observed by horizontal cracks around the edges of the beam and diagonally propagated cracks the center of the specimen (Fig. 8 & 13). If the beam fails due to flexure the specimen would have noticeable vertical cracks distributed near the center of the beam (Fig. 8&12), because moment reaches its maximum value at the center of the beam.