8. FINITE ELEMENT ANALYSIS

8.1. Introduction

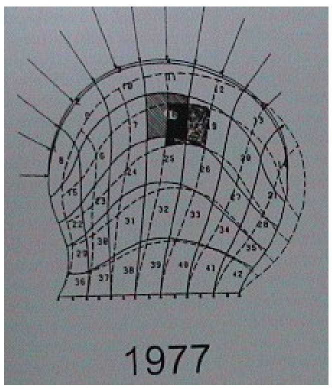

Figure: 8.1. Finite element analysis

Finite element analysis-A numerical method for solving an equation by approximating continuous quantities as a set of quantities at discrete points, often regularly spaced into a so-called grid or mesh. Because finite element methods can be adapted to problems of great complexity and unusual geometry, they are an extremely powerful tool in the solution of important problems in heat transfer, fluid mechanics, and mechanical systems. Furthermore, the availability of fast and inexpensive computers allows problems, which are intractable using analytic methods to be solved in a straightforward manner using finite element methods [15].

8.2. Finite element study

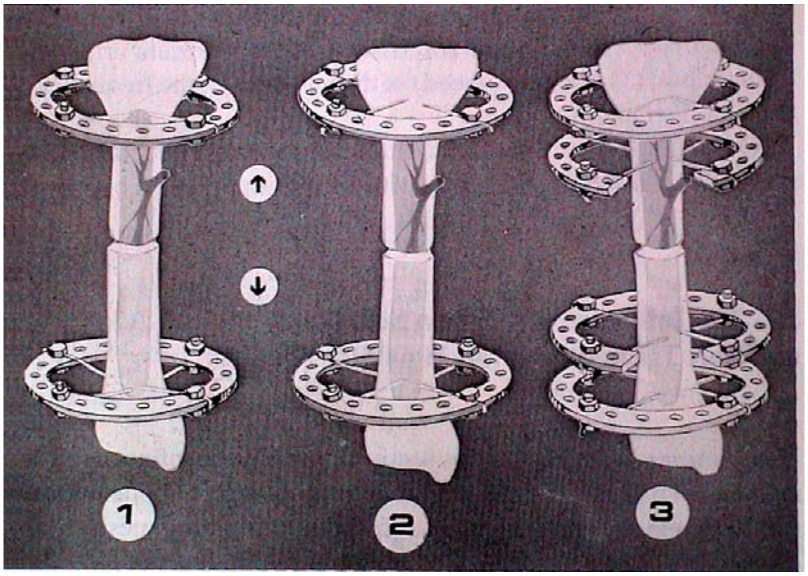

Figure 8.2

1. 2 rings, open osteotomy, loose wires,
2. 2 rings, open osteotomy, tensioned wires,
3. 4 rings, open osteotomy, tensioned wires,

Load on bone was 40 kg (400 newton)

Pre tension on wires was 100kg (1000 newton)

Youngs modulus of bone – isotropic material – 10Gpa

Yield strength of steel 400 N / mm 2

Youngs modulus of steel – 210 Gpa.

A transverse fracture with a gap of 1mm

The study was conducted using ABAQUS Software. 3D beam elements were used for the study. 80 – 100 elements used depending on the model. The fracture site was modeled with no compatability between the nodes. In other words, two nodes are made to occupy positions very close to one another and are not tied.

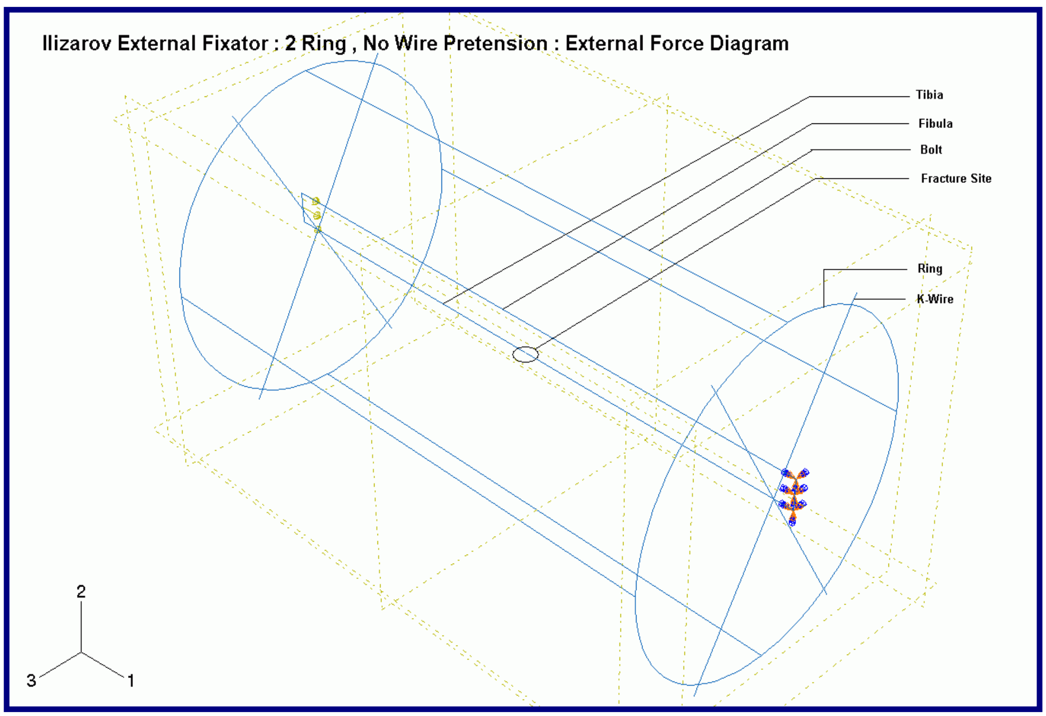

Figure 8.3 - External forces in Group 1 construct.

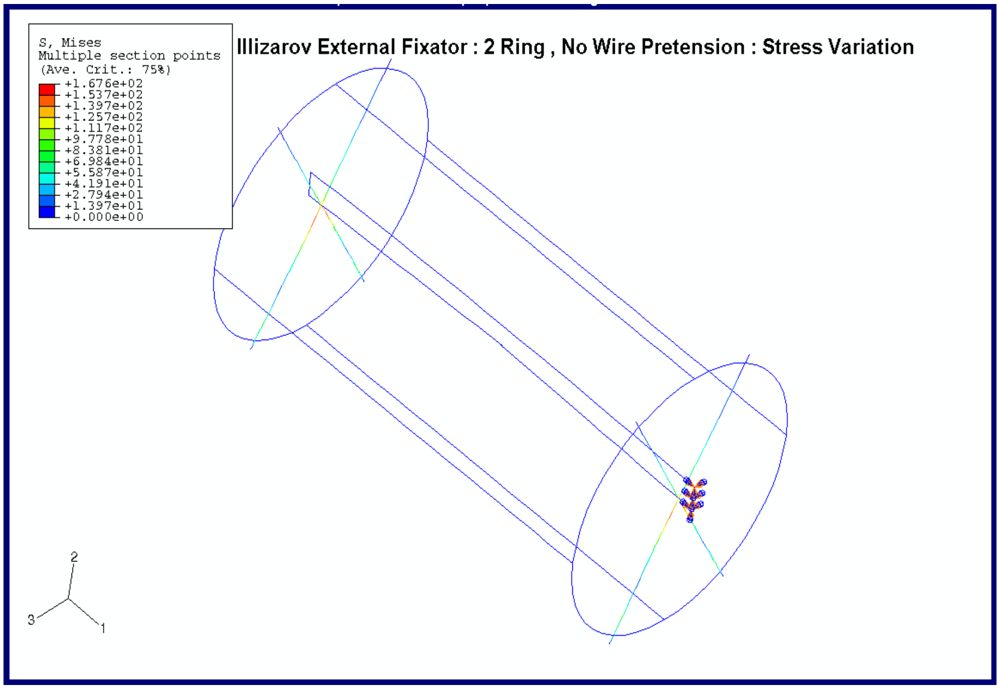

Figure 8.4 - Stress variation in Group 1 construct

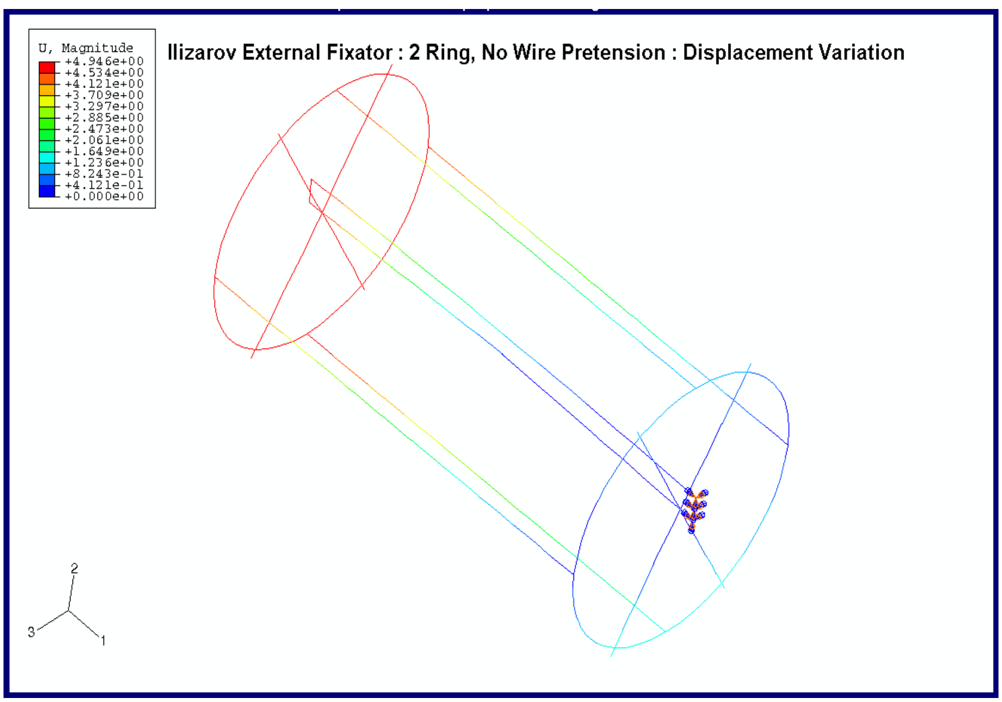

Figure 8.5 – Axial displacement variation in Group 1 construct.

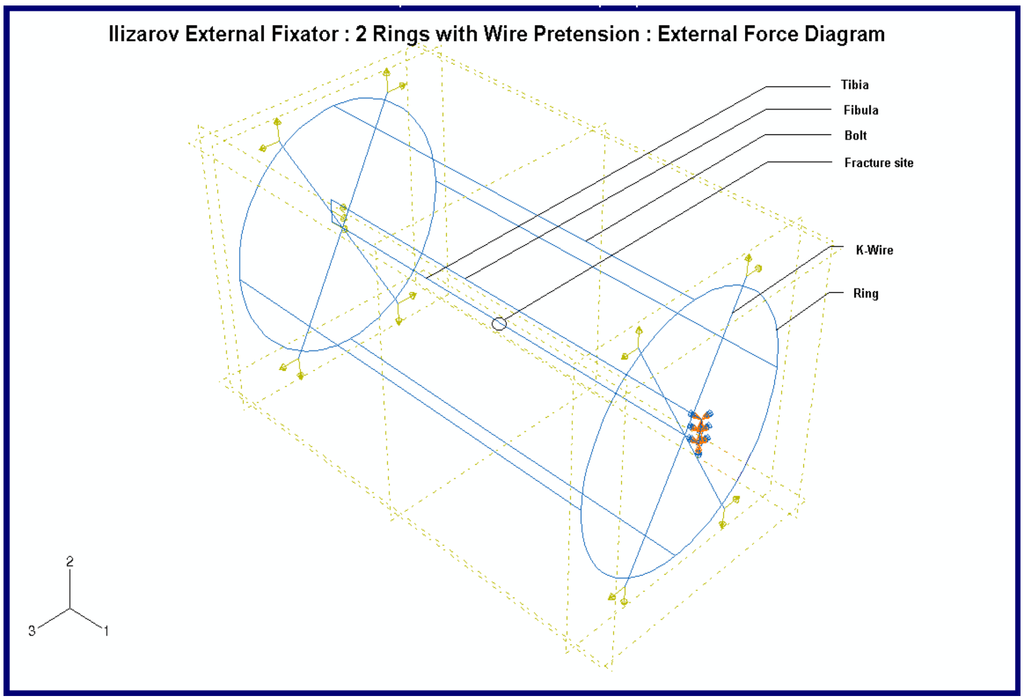

Figure 8.6 - External forces in Group 2 construct.

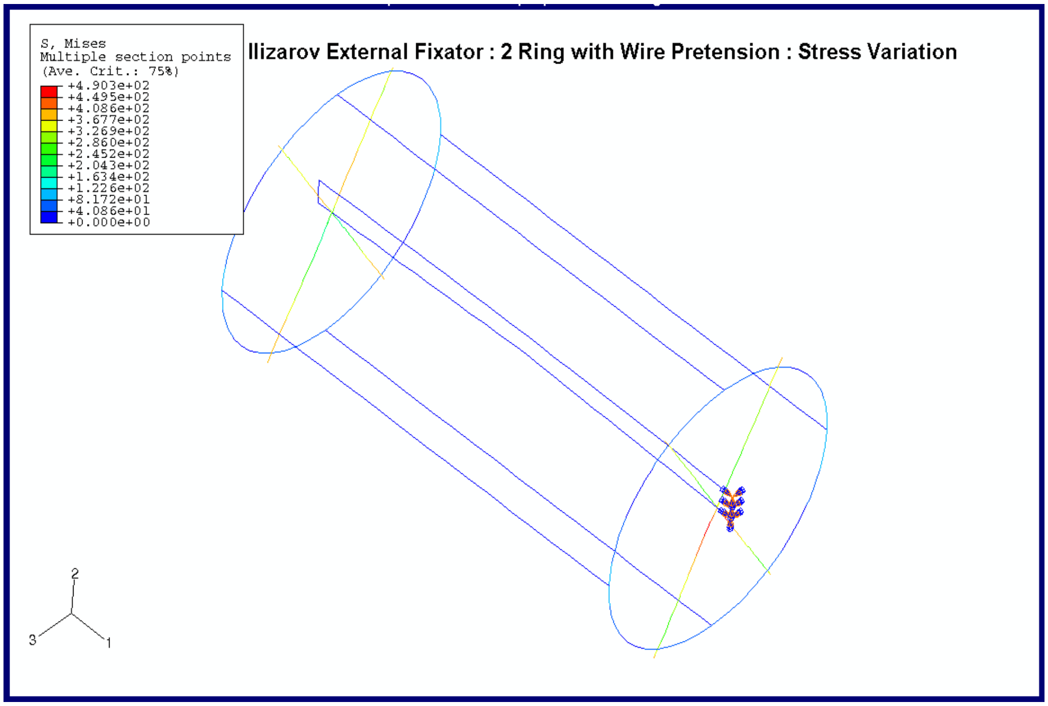

Figure 8.7 - Stress variations in Group 2 construct.

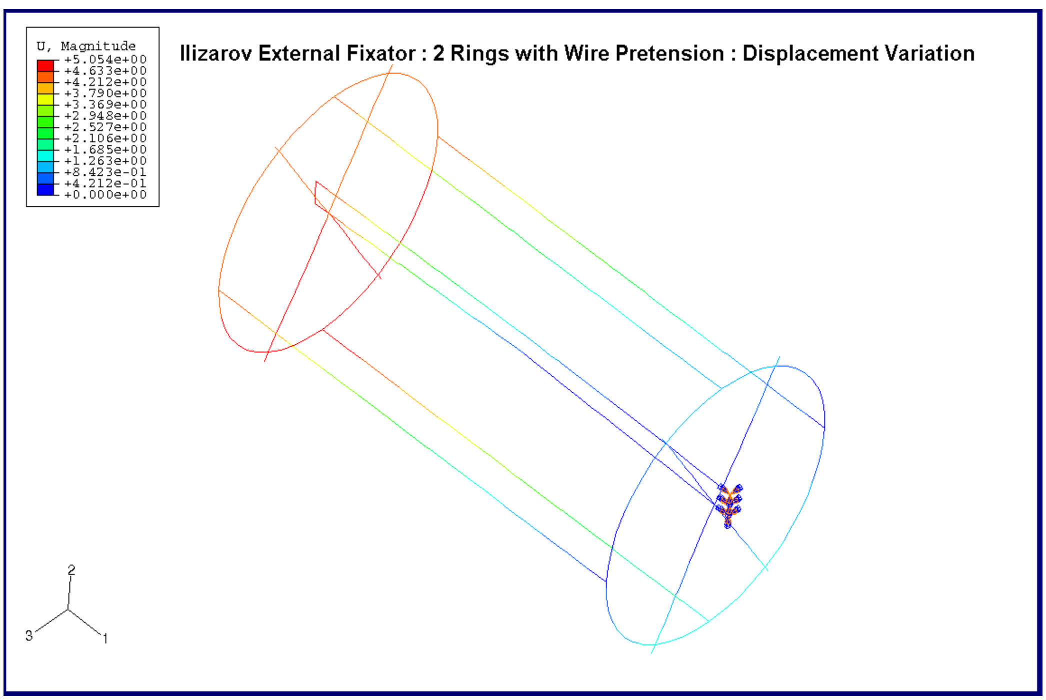

Figure 8.8 – Axial displacement variations in Group 2 construct.

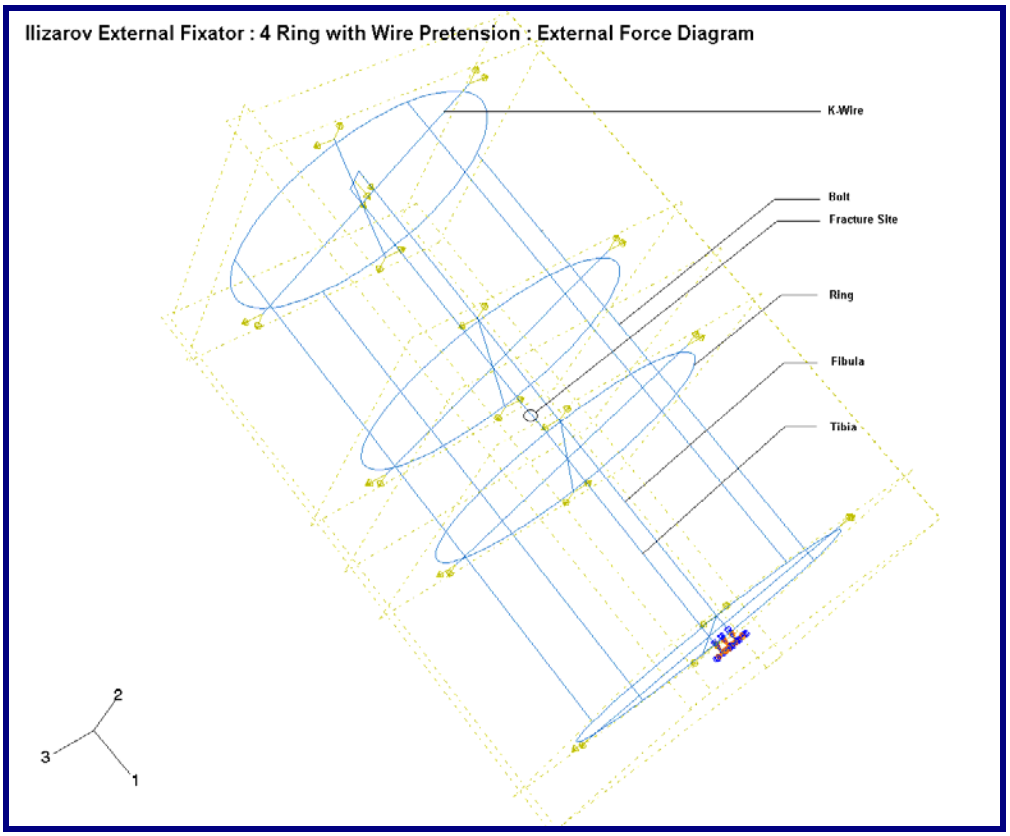

Figure 8.9 - External forces in Group 3.

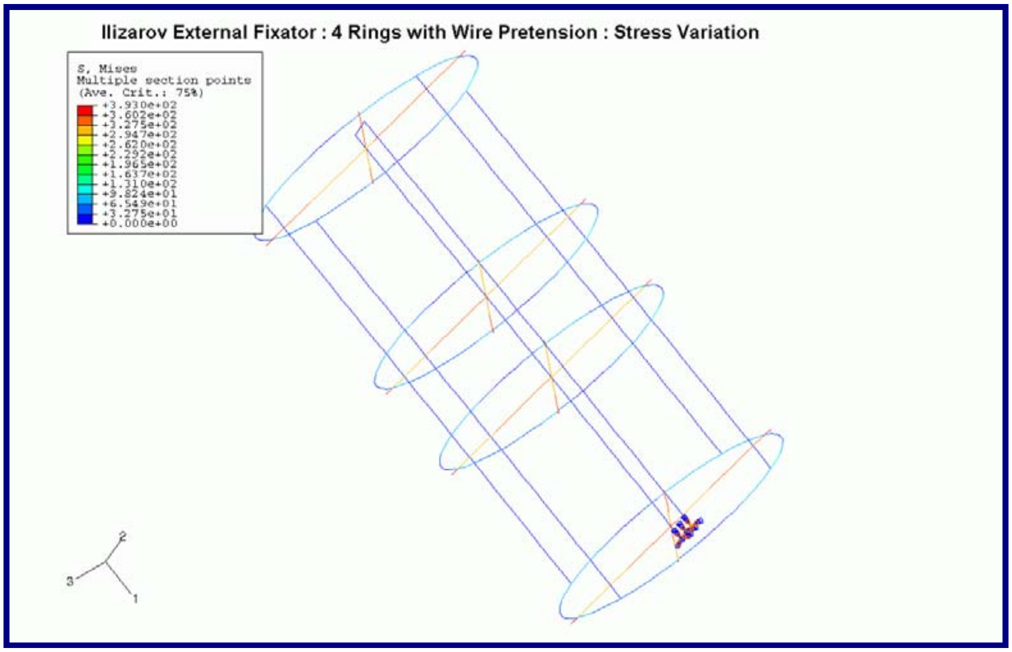

Figure 8.10 - Stress variation in Group 3.

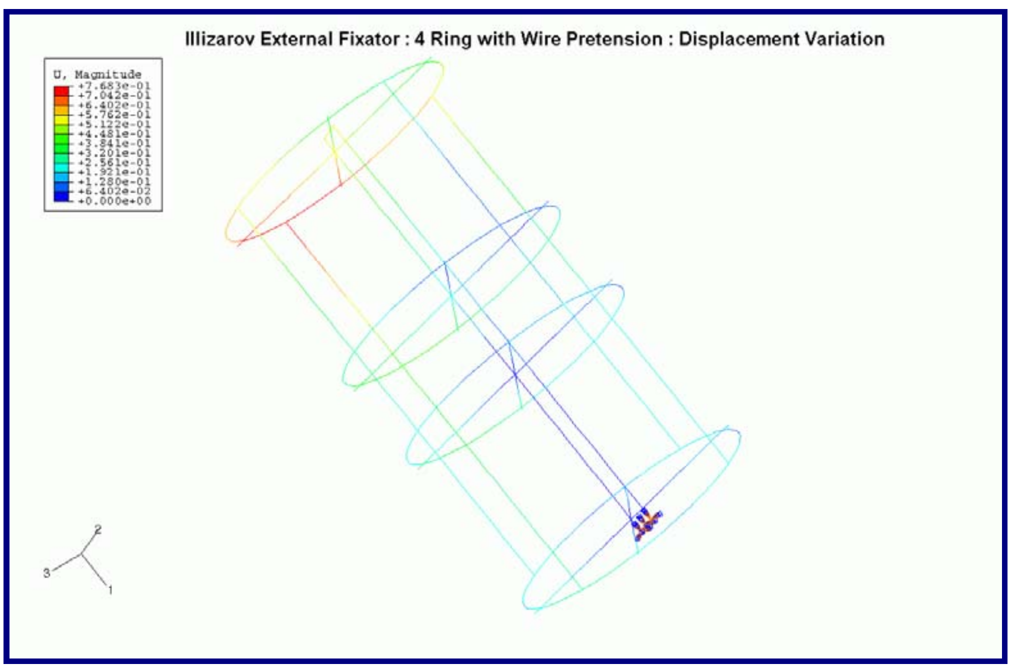

Figure 8.11 – Axial displacement variation in Group 3.

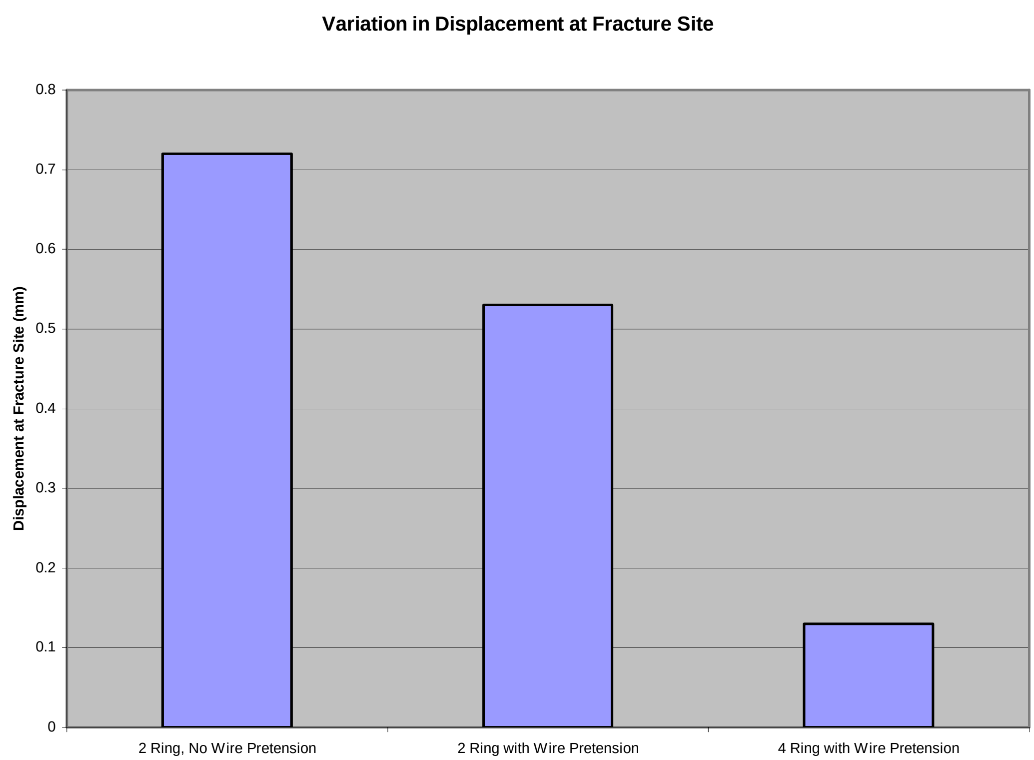

Figure 8.12 – Axial displacement variation in Group 1, Group2, Group 3.

8.3. Results of finite element study

The results of the finite element study with above diagrams shows the whole stress goes in the wires in transverse fracture stabilisation with a fracture gap of 1 mm. The axial displacement graph shows there is least displacement of 0.1 mm in 4-ring construct with pretensioned wires and there is 0.5 mm displacement in 2-rings construct with wire pre tension and 0.7 mm displacement in 2 rings construct with no wire pretension. The results of the finite element study correspond with Experimental ossification study. In 2 rings construct without wire pretension the ossification is least, with wire pretension better than no wire pretension. In 4 rings with wire pretension the ossification was better than 2 ring construct. With closed osteoclasis the ossification is the best and shows biological factors are also required for ossification. This study shows Ilizarov ring fixator system is biomechanically stable, yet dynamic with tensioned thin wires allowing cyclic axial movement to take place in fractures and in distraction osteogenesis which helps in bone healing and regeneration.