INFLUNCE of Rigid Pavement Ferro-Cement under Impact Loads as Aircraft loads In Egyptian Airports

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ABSTRACT:

The largest major industries in any country in the world is industries of aircrafts. In Egypt, this sector accounts of Egypt's gross international connection, making it the most important industry for the country's economic progress. Many projects in Airports are constructed to meet the needs of Egyptian sustainability development vision 2030.the current work, showed rigid slab as like Runways and aprons but it made by scale. Showed Loads of Aircraft as impact load but it made by scale. Experimental studies made scale of rigid pavement slab equivalent dimension of rigid pavement slab and used equivalent impact load for impact aircraft load in runway and aprons.in this work, made experimental work with using various types of mesh (Tensar, Tenax, Gavazzi, welded and expanded) mesh, various types of sieve slags, high slag cement and made rigid pavement under impact load (steel ball). Made numerical work by using ABAQUS 6.13 software. The current model was verified against previously published experimental investigations on RC slabs under impact loads (Batarlar (2013)). Based on this results, it observed that the performance of slabs by finite element and experiential works. In this paper, made comparison between this numerical and experimental result with using different material in making rigid pavement slabs.

Key Words: Rigid pavement Slab; Impact load; Slag.

1. INTRODUCTION:

The construction industry is one of the largest if not the largest major industries in any country in the world for both developed and developing countries alike. In Egypt, this sector accounts of Egypt's gross domestic product, making it the sixth most important industry for the country's economic progress. Annually, many projects are constructed to meet the needs of the Egyptian society such as bridges, tunnels, highways, airports, oil and gas…etc.

This thesis reports efficient experimental studies and studies highlighting behaviour of reinforced concrete slabs with using slag in Ferro-cement under vertical impact loads. It also, provides useful information regarding the behaviour of slabs strengthened by metal mesh under vertical impact loading, which may be used to design guidance for aerodrome engineers and improve the design runways and aprons in Egypt. Experimental studies use equivalent impact load for impact aircraft load and make scale of rigid pavement slab equivalent dimension of rigid pavement slab in runway and aprons.

2. EXPERIMENTAL PROGRAM

2.1Material Properties

- Concrete

The concrete used in this thesis was high slag cement from Assiut Cement Company. Figure 1 shows the mechanical and physical properties.

Fig 1: Mechanical and Physical Properties

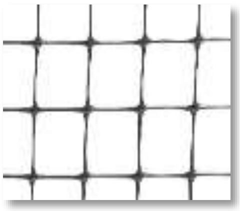
Steel Reinforcement

The reinforcement used in the experimental program is EZZ steel company. Steel used 1Ǿ5.5 mm welded steel mesh as Figure 2.

Fig 2: Steel Reinforcement

a. Mesh Reinforcement

Tensar mesh



Tenax mesh

Gvazzi Mesh

Welded Mesh

Expanded Mesh

The mesh reinforcement used in the experimental program is Tensar, Tenax, Expanded, Welded and Gavazzi mesh as figure 3.

Fig 3: Types of Reinforcement Mesh

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- **Slag Aggregate**

The slag used as fine and coarse aggregates. Fine Slag aggregate passed from sieve #4.85mm as figure 4. Coarse slag aggregate passed from sieve #9.50 mm and reserved in sieve #4.85mm as Figure5.

Fig 4: Fine Slag Aggregate.

Fig 5: Coarse Slag Aggregate.

- **Impact Load**

Impact load equalled equivalent aircraft loads. Using steel ball failed of free weight 13.75 Kg from height 4.30 m as impact load.

Fig 6: Steel Ball (impact load).

- **Additional Materials**

Additional materials were Super Plastizer (Sikament), Fly Ash, Silica Foum and Polypropylene E#300.

- **Steel Indicator**

Steel indicator used with graded ruler showed the displacement value under impact load as figure 7.

Fig7: Steel Indicator.

In this test used supporting steel frame as figure 8 and using graded ruler to record maximum defalcation under impact load as figure 9. This ruler fixed in wooded block.

Fig 8: Supporting Steel Frame

Fig 9: Graded Ruler

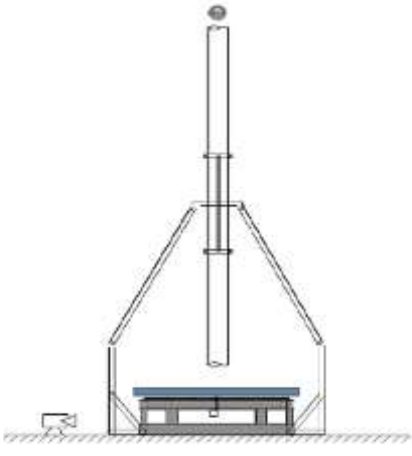

Fig10: Experimental Test

In this paper, make models simulate weight of big aircrafts (impact load) and dimension of slabs for rigid pavement in runways and aprons in Egypt airports using suitable scale. The big aircrafts for Egypt airports are B777-400ER, B747-800, A380-800 and An-225Mriya, take scale 1:3600 and using impact load equal 13.75 kg the experimental program. In the slabs of rigid pavement take scale 1:5 and using slabs dimensions (1200*1200*50) mm in the experimental program.

Fifteen samples of R.C slabs, two control with / without fiber and thirteen slabs with different number for meshes layers as table (1). Experimental works make in the laboratory of resistance and testing materials in Civil Engineering Department, the Faculty of Engineering and Menoufiya University.

Table (1): Reinforced Mesh of Slabs.

N	slab	Type of mesh	Steel Reinforcement	End Conditions
1	S1	2 Welded Mesh Layer	Steel mesh 1Ǿ5.5 mm	Simply Supported
2	S2	1 Tenax Mesh Layer		
3	S3	Control Slab With Fiber		
4	S4	3 Welded Mesh Layer		
5	S5	1 Welded Mesh Layer		
6	S6	1 Expanded Mesh Layer		
7	S7	3 Tensar Mesh Layer		
8	S8	1 Tensar Mesh Layer		
9	S9	2 Expanded Mesh Layer		
10	S10	3 Expanded Mesh Layer		
11	S11	2 Tenx Mesh Layer		
12	S12	Control Without Fiber		
13	S13	2 Tensar Mesh Layer		
14	S14	1 Gavazzi Mesh Layer		
15	S15	2 Gavazzi Mesh Layer		

All slabs have the same dimensions (1200*1200*50) mm with the reinforcement for all sides. Slabs could be welded reinforced 1Ǿ5.5 mm arranged in mesh form as figure 11. The material contained in slabs as table 2.

Fig11: Types of slabs

Table 2: Quantities of Concrete Mix

Materials	Cement	Water	Coarse Slag	Fine Slag	Silica Foum	Fly Ash	Super Plasticizer	Polypropylene Fibers
Quantity Kg / m^3	490	245	839	419.5	70	140	14	1.4

Pretested process made to ensure correctly the equipment performance. It included:

- Placing and installing the steel frame which selected inside the parts as figure (15).

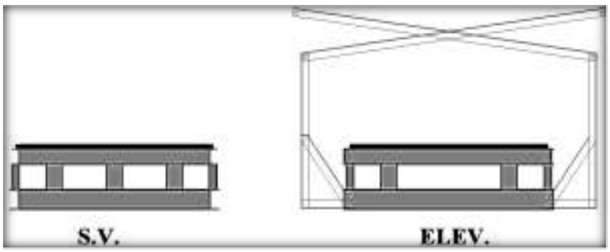

Fig 12: Steel Frame.

- Ensure the stability of steel frame equalled the ground level. Using water balance to adjust the horizontally slab sides as figure 13.

Fig 13: Adjusting Horizontally Steel Frame.

- Placing and installing PVC pipe correct vertically. Using four steel angles to vertical PVC pipe stability with steel frame. Connecting wooden ladder with pipe to fail steel ball. Using water balance to adjust the vertically pipe.
- Placing the graded ruler under the slab to allow recording displacement showed in steel indicator.

Fig 14: Placing Graded Ruler Under Steel Indicator.

- Before dropping the steel ball turned on the camera to record the displacement.
- Finally, after dropping steel ball for slab test, clean under slab to actual record.

2.2 Experimental Results

This part shows the result of various rigid pavements slabs under impact load .


S2
S3
S13
S14

Table 3: Experimental Results

3.1 Displacement with time for slabs:

It showed from figure 15 to figure 29.

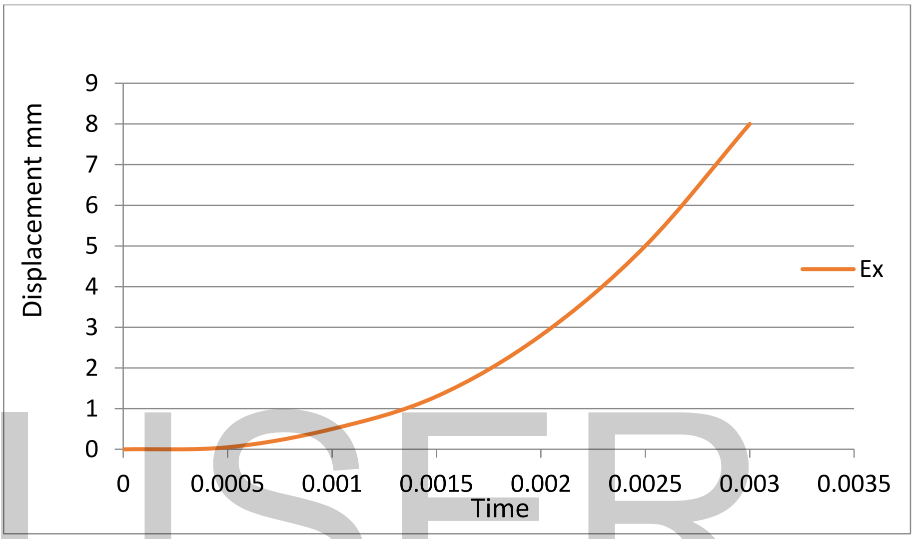

Fig 15: Displacement for S1

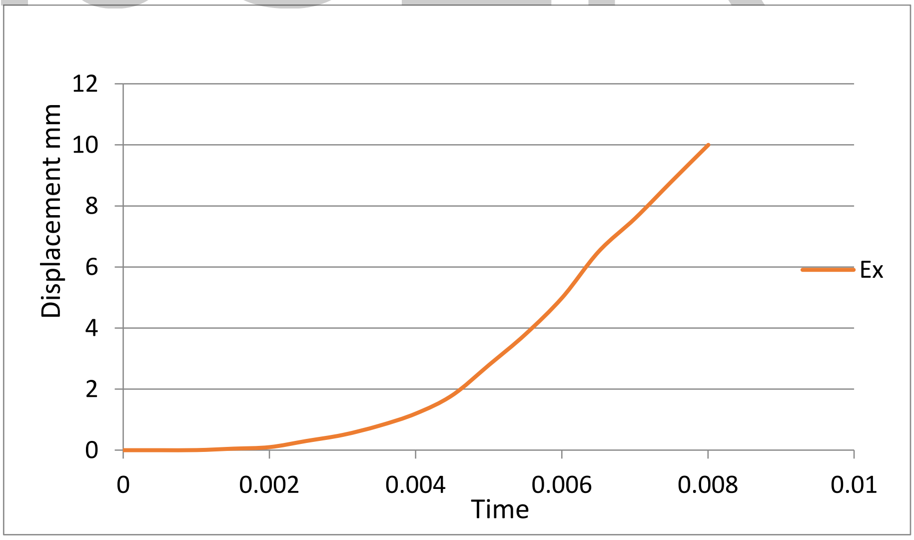

Fig 16: Displacement for S2

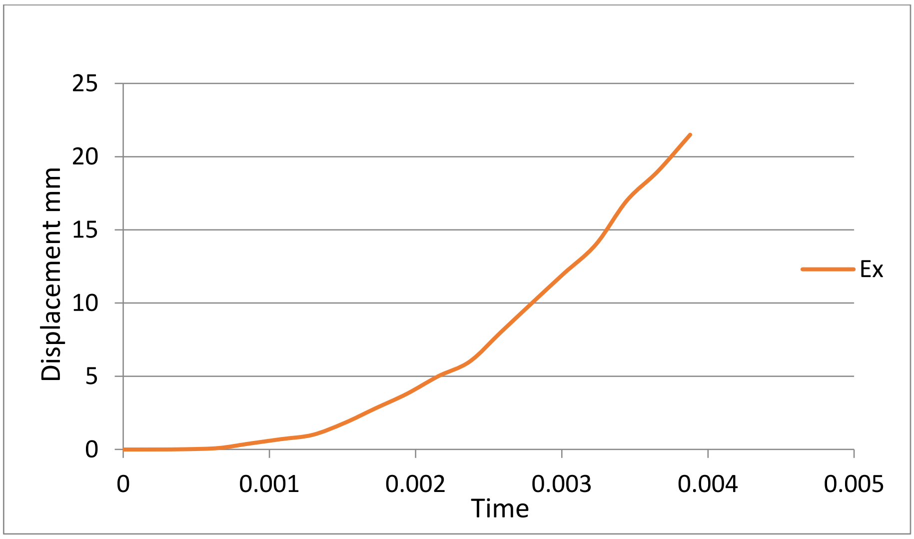

Fig 17: Displacement for S3

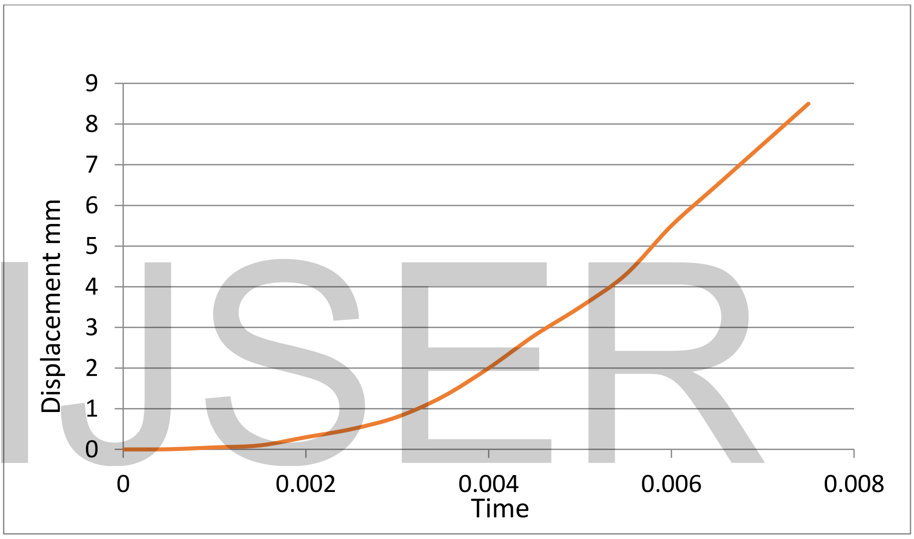

Fig 18: Displacement for S4

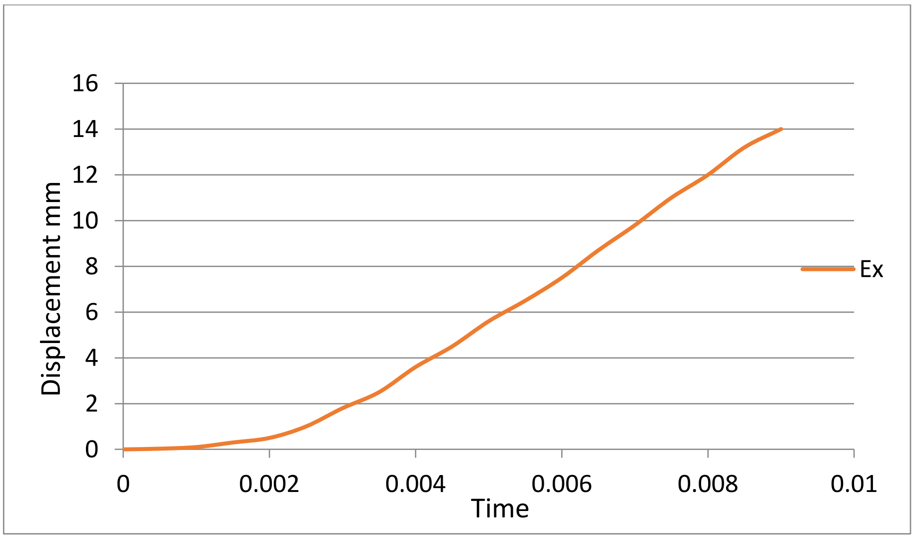

Fig 19: Displacement for S5

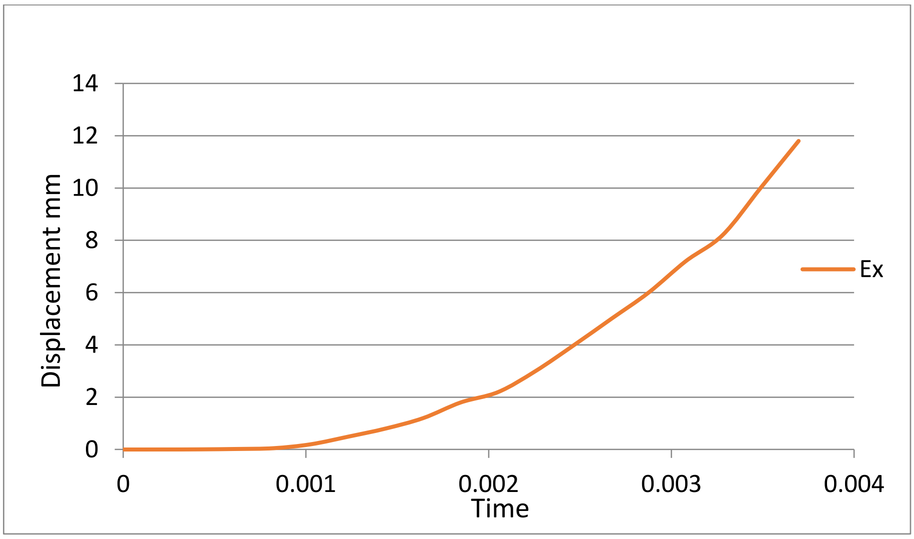

Fig 20: Displacement for S6

Fig 21: Displacement for S7

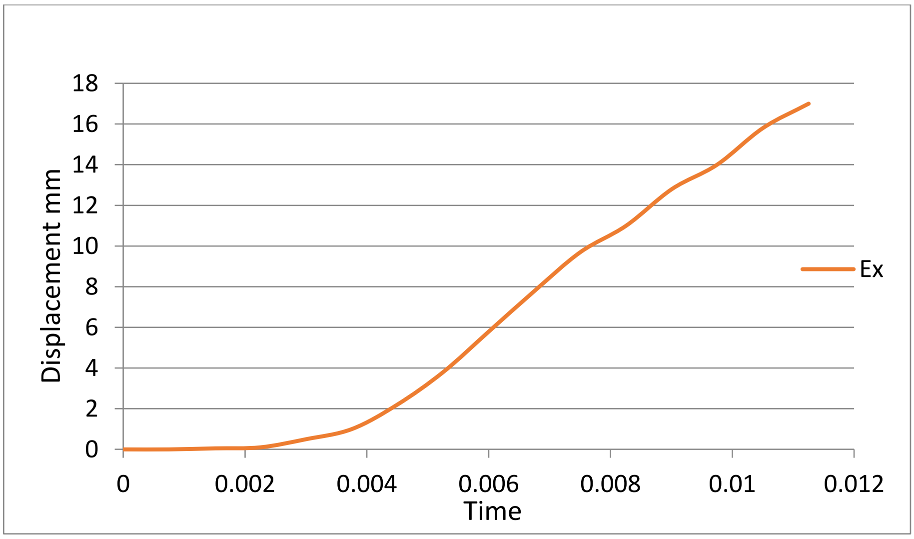

Fig 22: Displacement for S8

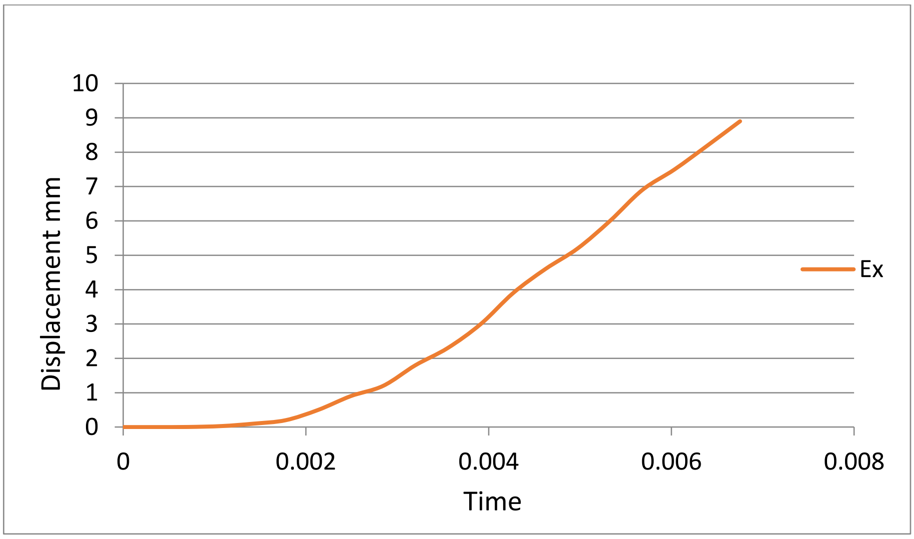

Fig 23: Displacement for S9

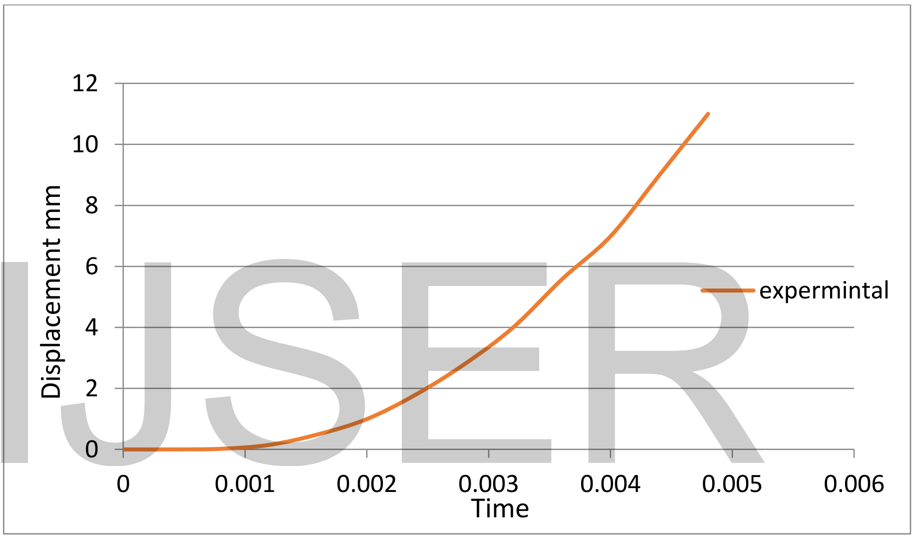

Fig 24: Displacement for S10

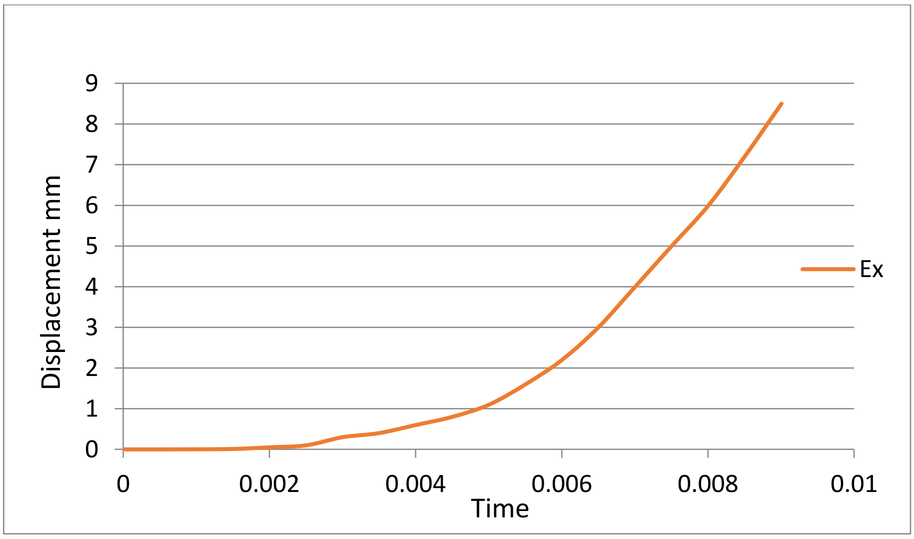

Fig 25: Displacement for S11

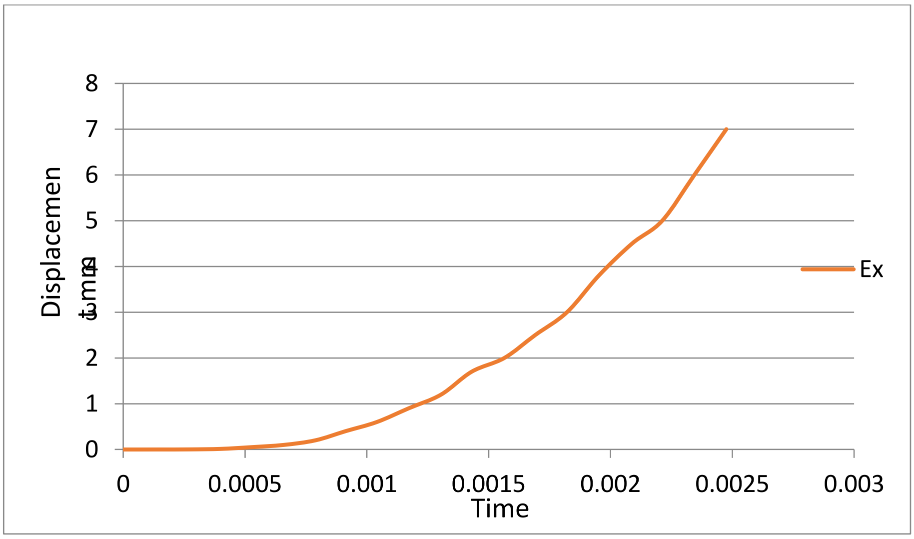

Fig 26: Displacement for S12

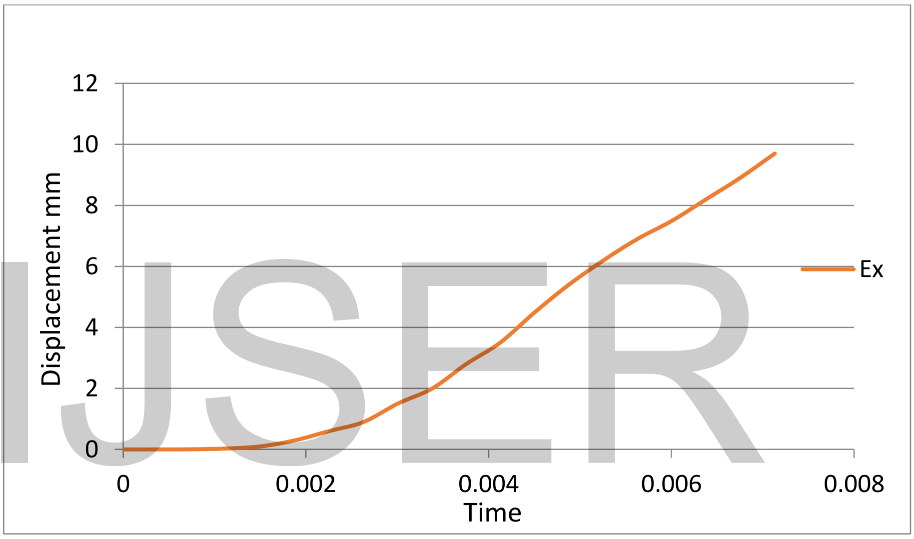

Fig 27: Displacement for S13

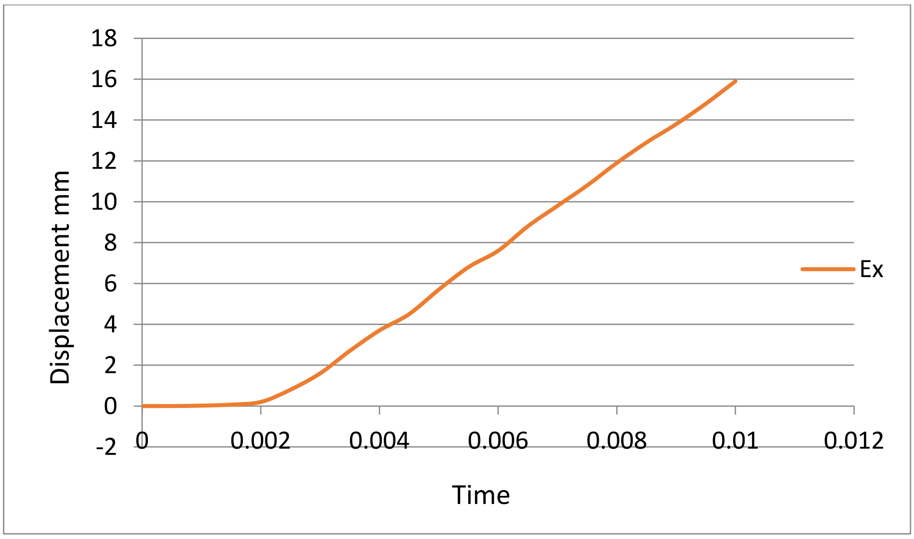

Fig 28: Displacement for S14

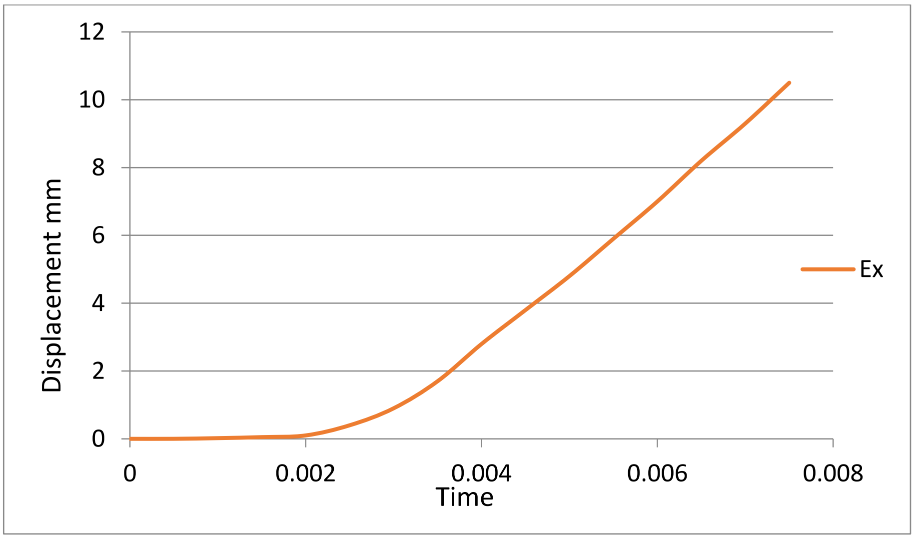

Fig 29: Displacement for S15

4 Comparison between different slabs displacement results by experimental

It showed from figure 30 to figure 61.

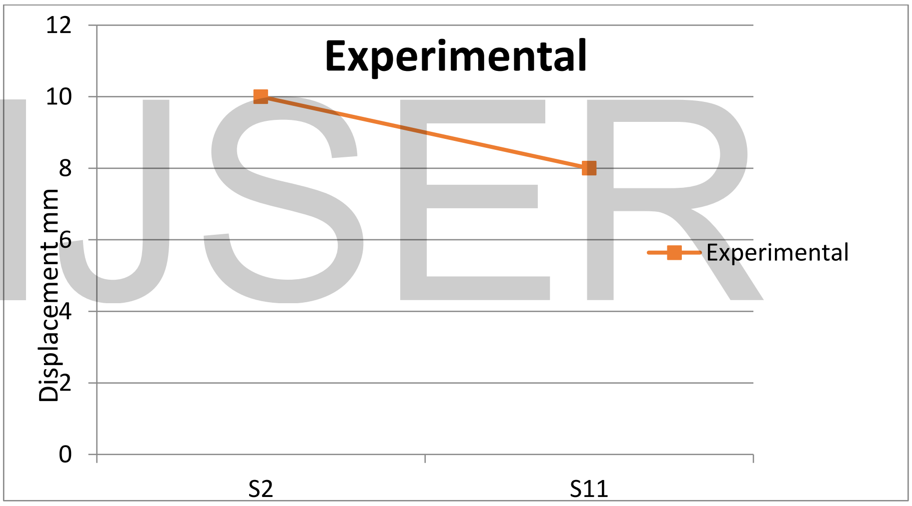

Fig 30: comparison between displacement results for S2 and S11

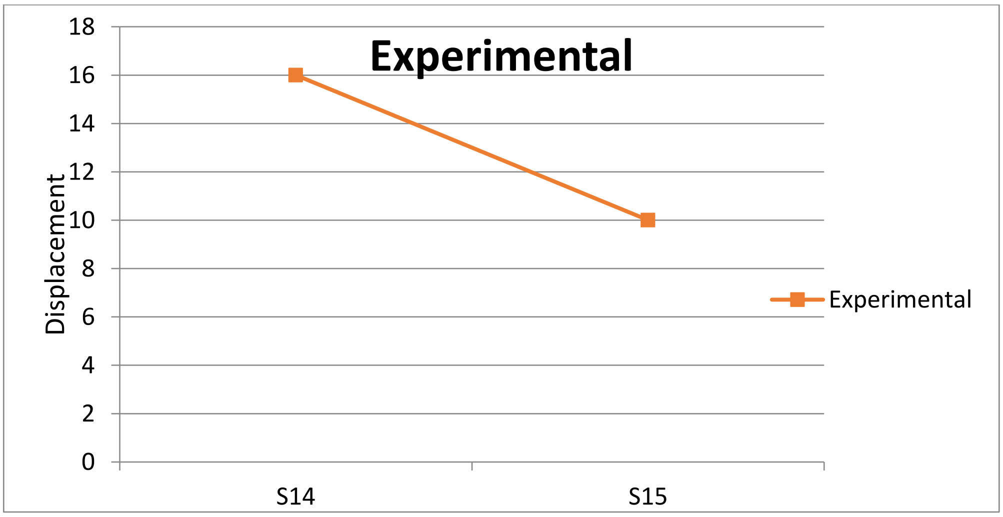

Fig 31: comparison between displacement results for S14 and S15

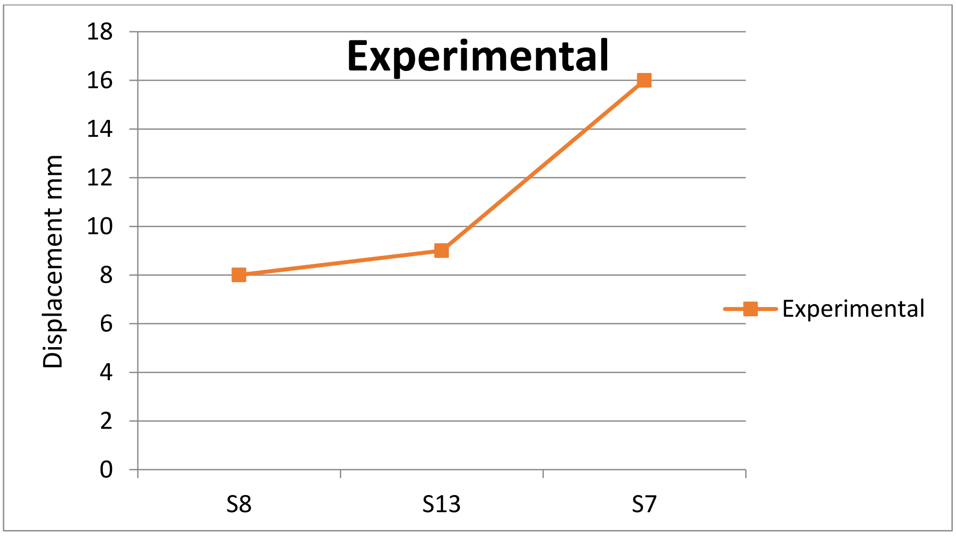

Fig 32: comparison between displacement results for S7, S8 and S13

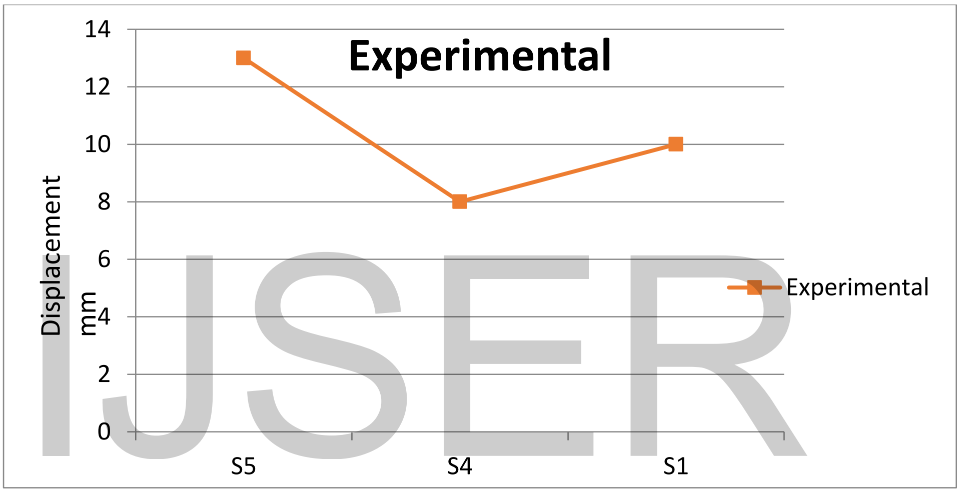

Fig 33: comparison between displacement results for S1, S4 and S5.

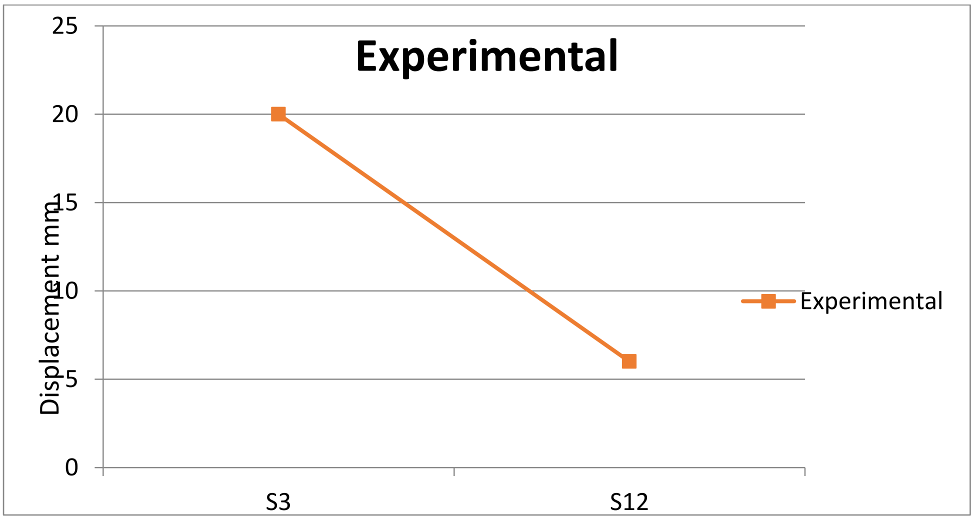

Fig 34: comparison between displacement results for S3 and S12.

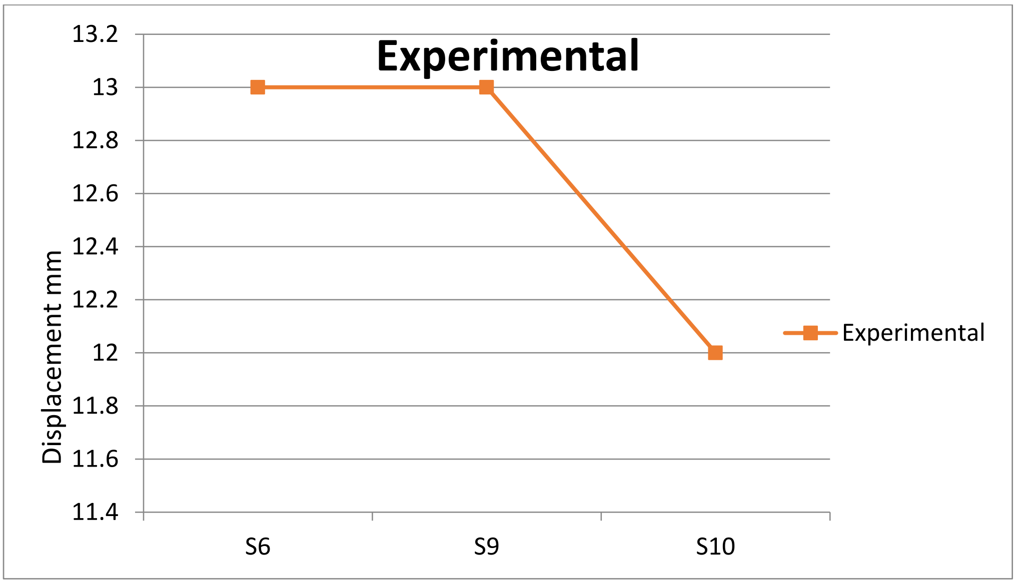

Fig 35: comparison between displacement results for S6, S9 and S10.

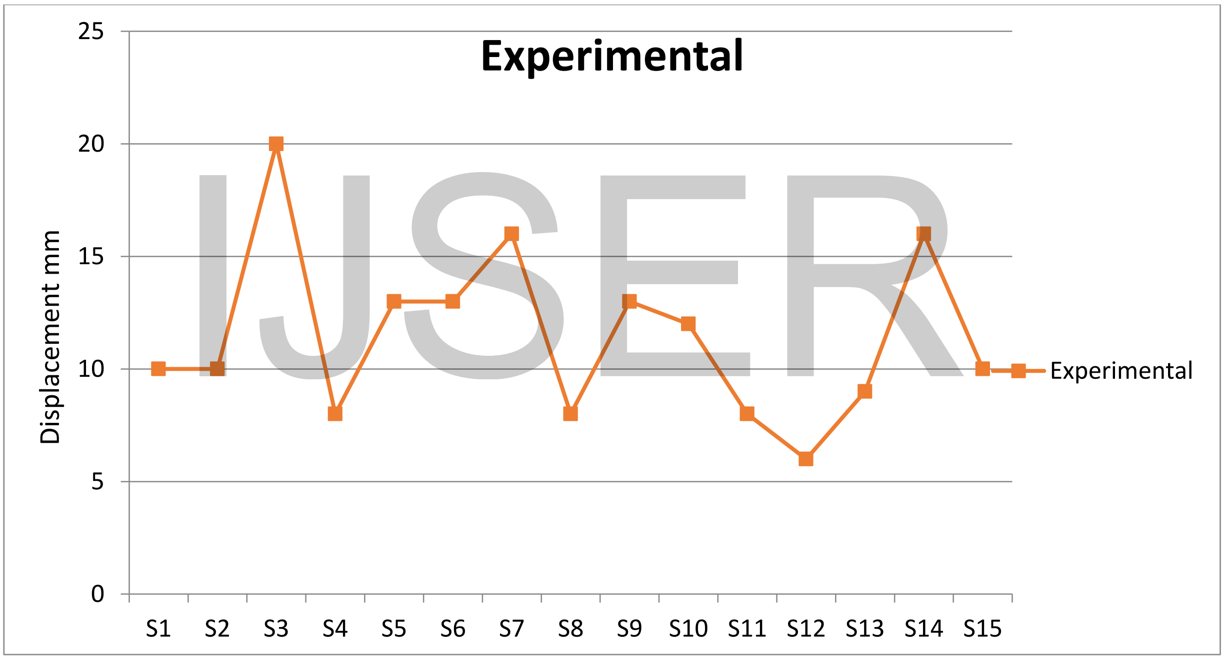

Fig 36: Cumulative comparison between displacement results for all slabs

3. CONCLUSIONS:

The current work showed to investigate dynamic behaviour of rigid pavement slabs under impact loads as Aircraft load.

Based on the experimental results showed in the current study, various conclusions may be drawn and can be summarized as follows:

1- Using tenax and tenser mesh is the best under impact load as aircraft loads.
2- Using slag and various mesh made high strength against failure.
3- Using tenax and tenser mesh is the lowest displacement under impact load as aircraft loads.
4- The worst case of deflections and damaged area showed when using slab without any mesh layers.

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