Structural Monitoring of bridges using Frequency Selective Surface

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Abstract : In this paper, Frequency selective surfaces are used to monitor the condition of structures like bridges. This is a wireless method of monitoring structures as previous methods were wired and therefore difficult to cover large areas. The electromagnetic wave characteristic of FSS will change by geometrical changes of FSS due to mechanical strain or structural failure. The changed feature is used as a sensing function. If the faults can be detected earlier sudden accidents can be prevented. Frequency selective surface with square patches having square aperture is proposed. The FSS is simulated using ANSOFT designer software. The simulation process shows that, as the incident angle changes the FSS characteristics changes which can be used as a data for our objective.

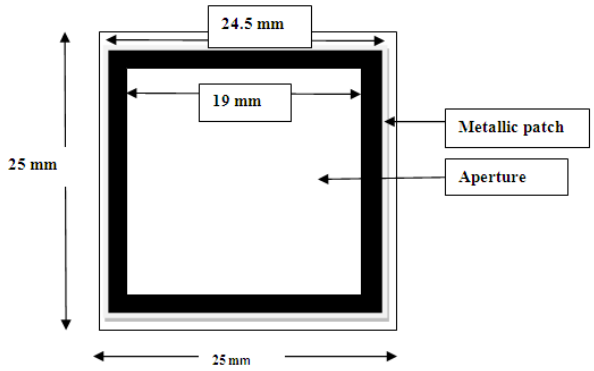
IndexTerms **- Aperture, FSS, patch, Normalized Transmitted Electric Field, SHM.**

I. INTRODUCTION

FSS is being investigated for the last few decades for its wide range of applications [1-4]. There are various techniques for Structural health monitoring (SHM). Earlier techniques were wired so it was difficult to cover large areas like a bridge. In this work, frequency selective surface as passive sensor for SHM is proposed. SHM using frequency selective surfaces is the recent application of FSS [5-6]. It has many advantages. It requires less cost as compare to wired techniques or other wireless sensors. Two dimensional periodic array of metallic patches on a dielectric sheet or apertures made on a metallic sheet supported by dielectric is called FSS [7-8]. These structures reflect or transmit electromagnetic waves when electromagnetic waves is incident on it. This reflection and transmission characteristics depends on the geometry of the structure. If there is a change due to mechanical strain or structural failure, in the geometry of FSS, the change is reflected in its electromagnetic wave characteristic. Therefore the change feature is used as a sensing function without any connecting wires. FSS with square patches, each patch having square aperture along with the transmission characteristics of SHM using FSS were discussed in this project. The simulation process has shown that incident angle characteristics can be use as a data for SHM application.

II. DESIGN OF FSS

The proposed FSS consist of two dimensional array of patches. Each patch is of size 24.5 mm x 24.5 mm. On each patch, one square slot of size 19mm x19mm have been cut out. Periodicity is taken 25mm in x direction and 25 mm in y direction. The patches are present on one side of a thin dielectric slab of thickness 0.8mm and copper coating on the other side of the slab is completely removed. The dimensions of each unit cell is shown in Fig.1.



. Figure.1 Unit cell (Patch with one square slot) under investigation.

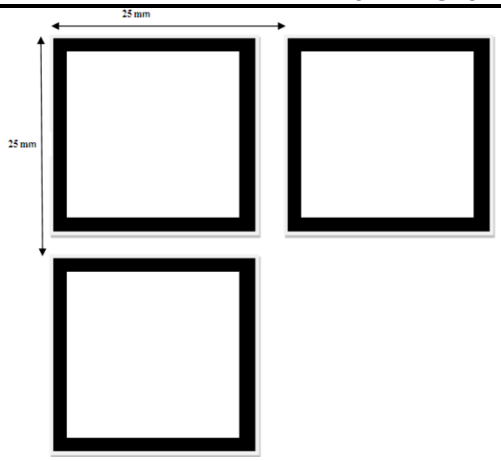


Figure.2 Two dimensional array of Unit cell (Patch with square slot) under investigation

III. RESULTS

The FSS containing square patches with square slot is simulated in ANSOFT Designer Software and the result have been plotted for comparison. This has been shown in the Fig. 3 and Fig 4. The results are also shown in Table 1.

Results in tabular form.

TABLE I: FSS with different incidence angle

S.No.	Θ (degree)	Φ (degree)	Resonant Frequency GHz	Transmitted Electric Field dB
1.	0	0	2.65	-60.17
2	20	20	2.85	-54.24
3.	30	30	2.89	-61.59
4.	40	40	2.95	-55.87
5.	60	60	3.03	-66.94

IV. OBSERVATION

It can be observed from table 1 and graphs shown in Fig.3 and Fig. 4 that, with change in angle of incidence the transmitted electric field as well as the resonant frequency varies.

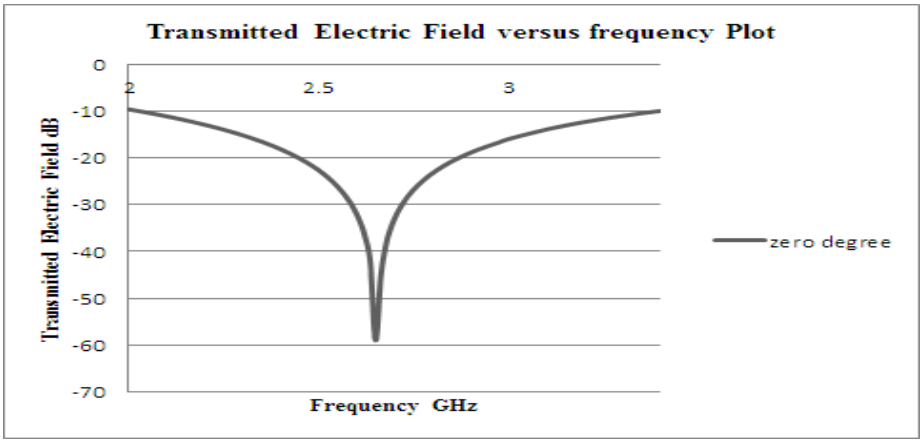


Figure.3. Graph showing FSS with zero degree incidence angle.

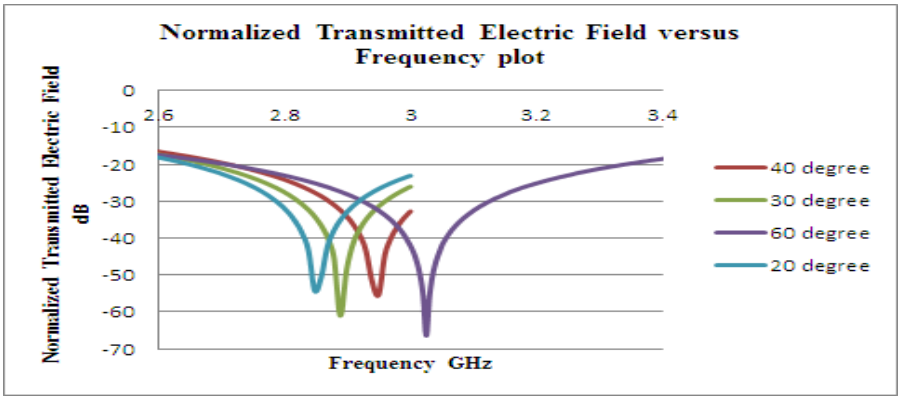


Figure.4. Graph showing comparative plots of FSS under investigation with different incident angles.

V. CONCLUSION

FSS consisting of square patches with square aperture has been proposed. Simulated results shows that the transmitted electric field and resonant frequencies varies with change in incident angle. So this can be a parameter to detect fault in structure of bridges. Therefore FSS can be used for structural monitoring of bridges.

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