ABSTRACT:
The high pressure or fluid tight applications call for added strength of the pipes carrying the fluid from the source to the point of use. Composite materials offer a promise for developing solution to such applications. The layered orientation of each material alongwith a binder can enhance the strength of the pipe. The FEA method can predict the behavior of the material subjected to deformation or its capacity to withstand the stresses encountered. Suitable FEA software like Nastran would be employed for finding the suitability of the given composition of the material for the intended application. The physical experimentation and validation would be done at the sponsoring Company/ Test Lab over a standard prototype.

RELEVANCE
In the recent past, composite systems are widely used in piping industries. The composite pipelines have the advantages of both metal and plastic, such as good mechanical properties of metal and good chemical properties of plastic. Therefore the composite pipelines are widely used in the areas such as water supply and drainage, heat supply, chemical engineering, petroleum and natural gas transportation, etc.

The properties of composites make them ideal in the severe oxidizing or reducing atmospheres generally found in these industries. For instance, in the chemical industry, corrosion resistance is the chief advantage. Under most severe corrosive environment, the life of steel can only be measured in a few days. Only the highest grade chromium-nickel-molybdenum (Cr-Ni-Mo) alloys can satisfactorily survive in these conditions. A more effective solution is the use of high molecular weight polymers coupled with suitable reinforcing materials.

Composites also have higher strength and stiffness to weight ratios compared to traditional engineering materials such as steel and concrete. Their low weight can help reduce installation and repair costs. Another important advantage of composites is the designer's ability to tailor the material properties for a specific application. High metal content provides maximum physical strength and high resin content provides maximum corrosion resistance. Thus the designer can combine these two elements to produce a satisfactory design[1].

The steel reinforced plastic (SRP) pipe is a product with two side corrosion resistant resin like high density polyethylene(HDPE) or polyvinyl chloride and sandwiched steel wired mesh structure for physical strength and hence better withstands to maximum working pressure. Inner and outer layer of resins are adhesively secured to the interlaying steel frame with a dried, solvent-free thin layer of a thermostetting bilayer adhesive which provides a bond with the metal.

The design and analysis of composite pipe is challenging and intricate problem. For the complete and accurate analysis of composite pipe, it is very necessary to recognize and utilize the factors which are imperative to design. This study establishes 3D CAD models of steel wire reinforced composite pipe having two different types of winding profiles. The types of winding profiles under study are mentioned below.

1. Rectangular winding.
2. Perforated winding.

The proposed study includes analysis of the displacement and stress distribution of the pipes under constant internal and external pressure by using FEA software. The differences between path displacement and stress distribution of the two kinds of composite pipes are elaborated by comparing the displacements of the distribution curve along their corresponding paths.

PRESENT THEORY AND PRACTICES
A brief review of some selected references is presented below.

The mechanical properties like specific strength, specific stiffness, fatigue strength and impact properties of filament wound composite tubes under internal pressure were discussed by Pinar Karpur [2]. A series of experiments were conducted to find out the maximum hoop stresses and strains formed during loading conditions, elastic constant in hoop direction to understand the behavior of filament wound composite tubes subjected to internal pressure.

Ehsan Ameri et al. [3] examined the sandwich pipes made of resin core and filament-wound skins to analyse the thermo-mechanical performance. They exposed such pipes to thermomechanical loading, due to hot compressed fluid that flows into them. In their investigation, an elastic solution based on the three dimensional anisotropic elasticity is presented for the orthotropic skin laminates and the isotropic core. An analysis of stresses, strains, and displacements through the thickness resulted of optimum winding angles have been shown and discussed. The shear extension coupling is also considered in the skins. The temperature gradient field within the pipe is obtained by solving the conduction equation in each of layers. Having considered the effect of thermomechanical
loading on time and the pressure alone another time, ideal winding angles yielding the lowest failure coefficient is derived. Frimel et al. [4] reported a PVC/CPVC composite pipe with metal interlayer and process for making it.

In theoretical and experimental research, the static pressure process, equality of static pressure, blasting tests under stress distribution and deformation pipelines, analyzed by finite element method [5]. Safa Sadat Masajedian [6] studied the properties of steel wire reinforced plastic pipe under short-term blasting pressure, strain, buckling critical pressure and the different temperature failure forms.

The American research and production department of composite pipelines paid much attention to production technology, and the departments like American Society of Testing and Materials have enacted a series of related standards [7]. Currently there is a major concern about the exact solutions to the stresses and strains in pipeline when it bears the internal and external pressure and axial force, the effects of high temperature and water hammer effect, failure forms etc. [8].

The above review shows that a considerable work has been reported on application of advanced composites & reinforced plastic materials for piping applications. However, very little work has been reported on orientation and/or profiles of reinforced metal matrix. Hence it is proposed analyze using FEA two different winding profiles that can be used in case of composite pipes. A finite element model of a composite pressure pipe will be established using ANSYS.

PROPOSED WORK
The purpose of this study is to investigate finite element models of two kinds of reinforced steel windings used in SRP pipes to analyze them in order to evaluate their performance. The detailed work includes modelling & analysis of two types of winding profiles used in steel reinforced plastic pipes and its comparison with the standard steel pipe. Two types of winding profiles to be considered include the rectangular winding profile and the perforated sheet winding profile. The FEA results of standard steel pipe and steel reinforced pipe will be compared with analytical results by using standard empirical formulae and experimental results respectively. The work will be focused in order to,

- Evaluate the stress distribution and bursting pressure.
- Find the alternative design as a replacement for conventional steel piping structures.

The above work is planned in following phases.

Phase I: -

a) Detailed literature review is to be carried out at initial stages. Collection of literature from various available resources and thorough study of relevant literature is involved in this phase.

b) Study of the concepts in reinforced metal composite piping design, materials and strength requirements.

Phase II: -

a) Selecting an existing standard design of steel pipe for study.

b) CAD modelling of the selected design.

c) Stress distribution and path displacement analysis of the modelled steel pipe.

Phase III: -

a) Selecting the proposed winding profiles namely rectangular winding profile and perforated winding profile.

b) CAD modelling of the selected designs.

c) Stress distribution and path displacement analysis of the modelled SRP pipe design.

Phase IV: -

a) In addition to the computer analysis, experimental investigations will be carried out for SRP pipes and analytical analysis will be carried out for steel pipe using standard empirical formulae to determine the bursting pressure of the respective pipes.

b) Obtaining the comparative statistics between conventional steel pipe structures and proposed alternate Plastic-Metal composite pipes with two types of winding profiles.

c) Proposing the alternate design for pipe & associated cost and weight reduction benefits.

REFERENCES
1. Jack E. Helms, “Pressure vessels and piping system”. Composite materials for pressure vessels and pipes, Encyclopaedia for life support system.