CHAPTER 01

1.0 INTRODUCTION

In steel construction, there are two main families of structural members. One is the familiar group of hot rolled shapes and members built up of plates (HRS). The other, less familiar but of growing importance worldwide, is composed of sections cold formed from steel sheet, strip, or flat bars in roll-forming machine or by press brake or bending brake operation. These are cold formed steel structural members (CFS). The thickness of steel sheet or strip generally used in cold formed steel structural members ranges from 0.4mm to 6.4mm.

Construction industry in Sri Lanka has experienced a rapid increase in construction cost due to lack of traditional construction material. Therefore an increasing demand for alternative construction material has been seen in the last few years. Cold Formed Steel (CFS) is still a new concept to Sri Lankan construction industry. Developers, Contractors, and designers are also affected by the non availability of extensive studies on applicability of cold form steel and what / how CFS can be used so that it benefits construction industry. This study was aimed to fulfill above mentioned industry requirements in a detailed manner.

1.1. GENERAL ADVANTAGES OF COLD FORMED STEEL

In general, cold formed steel structural members provide the following advantages in building construction.

- As compared with thicker hot rolled shapes, cold formed light members can be manufactured for relatively light loads.
- Unusual section configuration can be produced economically by cold forming operation and consequently favorable strength to weight ratios can be obtained.
- Nestable sections can be produced, allowing for compact packaging and shipping.

- compared to other material such as timber and concrete, the following qualities such as
    - Lightness
    - High strength and stiffness
    - Fast and easy erection and installation
    - More accurate detailing
    - Uniform quality
    - Recyclable material; can be achieved from cold formed steel structural members.

1.2. MATERIAL PROPERTIES OF STEEL

Two basic yield strength of steel are generally used in cold formed sections, as defined in BSEN 10147

Fe E 280G - yield strength 280 N/mm^2 (Formerly Z28)

Fe E 350G - yield strength 350N/mm^2 (Formerly Z35)

Generally the cold formed steel is available as Galvanized structural members. Galvanized steel for cold formed sections are normally provided in a grade of zinc coating, G275, which corresponds to 275g/m^2 total coverage of zinc summed over both sides of the sheet. This is equivalent to 0.04mm approximate total thickness, which is normally included in the specified thickness of the sheet. Galvanizing gives additional corrosion protection for members in internal conditions or subjected to intermittent moisture, for example due to condensation.

1.3. PROBLEMS OF COLD FORMED STEEL MEMBERS

1.3.1 Buckling Failure

Since the thickness of the cold formed steel members is small, they are subjected to local buckling, distortional buckling, flexural buckling, flexural torsional buckling or their combinations. Generally short compression members fail due to local buckling and / or distortional buckling while long compression members fail due to flexural buckling, flexural torsional buckling or their combination. Lack of design rules is also a major issue with design of cold formed steel members as they are limited to general external conditions, such as general environmental condition, normal temperature etc.

1.3.2 Low Fire Resistance

One of the major issues of steel structures is that they can be subjected to fire which will cause loss of lives and properties, not only because of fire but also due to the structural failure of building due to deterioration of the mechanical properties of the steel at elevated temperatures. Therefore fire safety design of building structures has received greater attention in recent time. Series of researches have been conducted on cold form steel behavior at elevated temperature and recommendation have identified to adopt in both design and construction stage.

1.4. APPLICATIONS OF COLD FORM STEEL STRUCTURES

1.4.1 Deck / Cladding Applications

Cold formed steel is used for deck, roof cladding and wall cladding applications. In the case of roof and wall cladding usually cold formed steel with a thickness of 0.42mm or 0.48 mm is used. Cold formed steel is also used for composite decks. These deck systems should have sufficient strength to withstand the wet concrete load, construction load, reinforcement load etc. Usually trapezoidal profile is used for composite slabs.

1.4.2 Floor Systems

Cold formed steel members are used as floor beams with plywood boards or oriented strand-boards. The use of such floor systems leads to light weight structures.

1.4.3 Use as Truss Members

There is an increasing trend of cold formed steel in truss systems in industrial application. This is basically due to the better quality of cold formed steel members in terms of strength, various shapes, pleasing aesthetics, ease of connections etc.. compared to hot rolled steel or timber members.

1.4.4 Other Applications

Cold formed steel members are used as door and window frames, storage racks, frames for display boards, etc.

1.5. OBJECTIVE

The main objective of this research is to assess the benefit of using cold formed steel members on medium span roof trusses against the hot rolled steel members and encourage the innovative development of cold formed steel roof trusses for medium span roof structures in Sri Lanka.

1.6. SCOPE

This study is based on four case studies, which contain 4.0m, 8.0, 10.0m and 12.0m span roof trusses. All existing proposal for the aforesaid roof trusses were based on Hot Rolled Steel sections and now all structures are in operation stage. This Detailed study will assess and compare the exact benefits if CFS members are used for the same intended usage of above structure.

Further, the member connections for truss element were limited to plate and bolt connection only, for CFS design. The main reason for this was, lack of skilled labour available in CFS construction industry in Sri Lanka, as well as easy installation and

fabrication. The required parameters have been considered in CFS design stage for member connections.

By considering the availability of CFS section in Sri Lanka, the minimum section of 100x1.2-C was considered in the design. Again this research was limited to lipped channel sections only, as they are the most common sections available for cold formed construction in Sri Lanka.

The selection of truss type for particular span was depending on requirement raised by other parties that is Architects / Clients etc...

1.7. METHODOLOGY

In order to fulfill the above objectives, the following methodology was adopted.

I. Carried out a literature review
II. Identified the typical truss forms already adopted in Sri Lanka for industrial & commercial buildings
III. Analyzed the truss for permanent and wind load using finite element design software, SAP2000 as full scale 3D model. Analysis results were used in design of members, using separate spreadsheet developed, as illustrate in Appendix C.
IV. Determined the capacity of steel sections, and identified the optimum sections that can serve the intended usage for particular structure by both CFS and HRS. several iteration was carried out between analysis and design to figure out the optimum section for both steel family.
V. Determined the steel quantity requirement in each truss type and determined the cost efficiency for each truss forms for medium span roof truss.
VI. Compared the unit cost of roof structure under the same configuration for both type of steel roof structure.
VII. Identified limitation of using CFS for medium scale construction in Sri Lanka and recommendations were figure out.