Internship Report

On

Structural Analysis and Design of Industrial Building in McDonald Steel Building Products Ltd (MSBPL)

BRAC UNIVERSITY

Inspiring Excellence

Submitted To

Dr.Md. MamunHabib
Associate Professor
Department of BRAC Business School
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Submitted By

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ID: 15164021

DateofSubmission: 10September,2017

LETTER OF SUBMISSION

September 10, 2017

To

The Supervisor

Department of BRAC Business School

BRAC University

Subject: Regarding submission of internship report titled "Structural Analysis and Design of Industrial Building in McDonald Steel Building Products Ltd (MSBPL)."

Dear Sir,

I have the honor to let you know that I have accomplished my internship report titled on "Structural Analysis and Design of Industrial Building in McDonald Steel Building Products Ltd (MSBPL)." It gives me immense pleasure to submit the report before you. I made every endeavor to prepare this report and tried my level best to accumulate relevant and insightful information. It is a great experience for me to work with this topic. I have tried to make the report vivid and comprehensive within the scheduled time and limited resources.

If you need any further information to evaluate the internship report, it would be my enormous pleasure to furnish you the same. Your acceptance and appreciation would surely inspire me.

Sincerely yours,

Abdullah Mobarok

ID: 15164021

Semester: Summer 2017

Dept of BBS, BRACU

DECLARATION

I do hereby solemnly declare that the work presented in this internship report has been carried out by me and has not been previously submitted to any other University/Organization for an academic qualification/certificate/degree.

The work that I have presented does not breach any existing copyright and no portion of this report is copied from any work done earlier for a degree or otherwise.

Abdullah Mobarok
ID: 15164021
Semester: Summer 2017
Dept. of BBS, BRACU

SUPERVISOR CERTIFICATION

This is to certify that**Abdullah Mobarok;** Student ID No.:**15164021**; has done internship under my supervision. It is a part of thefulfillment of Masters of Business Administration (MBA) program in Department of BRAC Business School, BRAC University. The internship report titled “Structural Analysis and Design of Industrial Building in McDonald Steel Building Products Ltd (MSBPL).” can be submitted for defense.

Dr. Md. MamunHabib
Associate Professor
Department of BRAC Business School
BRAC University

ACKNOWLEDGEMENT

First of all, I would like to express my infinite gratefulness to Almighty Allah whose supreme mercy helped me to complete this report successfully. In addition, I would to extend my indebtedness to my parents and my better half SuranaTouhid. Their encouragement and support brought me here.

Obviously I wish to express my heartiest thanks, and a deep sense of gratitude to my supervisor Mr.Md. MamunHabib, Associate Professor, Department of BRAC Business School, BRAC University, for his deep insights, unequivocal and continuous guidance, valuable suggestions and encouragement in every stage of my progress.

I am also grateful to my colleagues F M MoinulHaq and ZeeshanYasirSakibfor their nice support and inspiration. I wish to complement my respective teachers of the department for providing such a nice environment for study.

It is my prayer that the motive behind this whole project will be fulfilled.

Abdullah Mobarok

Date: September 10, 2017

Executive Summary

Theobjectiveofthisreportistoanalyze the structural condition of the industrial building and design the structure accordingly.Theimplementationaimstohelp the construction of structurally safe building more economically, identifystructural challenges, selection of best possible pre-fabricated structural sections; preparing the bill of quantities to submit a competitive offer;andpreparing general assembly drawings based on which the buildings will be constructed after the client awarding the contract. Indoingso,thereportassessestheefficiency,effectiveness,valueadded,impact,usersatisfaction,coherenceandsustainabilityof construction of their desired buildings.

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CHAPTER ONE

INTRODUCTION

1.1Background

Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, vehicles, machinery, furniture, attire, soil strata, prostheses and biological tissue. Structural analysis employs the fields of applied mechanics, materials science and applied mathematics to compute a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability. The results of the analysis are used to verify a structure's fitness for use, often precluding physical tests. Structural analysis is thus a key part of the engineering design of structures. After analyzing the structure, a structural engineer should assign proper structural sections so that the structure can sustain existing loads along with wind and seismic loads. Structural members are beams, columns, sub beams, footings and other necessary sections that is required for an industrial building.

1.2 Rationale of theStudy

The purpose of this thesis is to studythe structure considering all loads and then designing the building according to the latest and updated building codes like BNBC, AISC and MBMA. This study will be done to fulfil partial requirements of MBA Program of Department of BBS, BRAC University. I believe this thesis will be a perfect blend of the theoretical and practical knowledge.

1.3 Objective of the Study

The study of Structural Analysis and Design of Industrial Building in McDonald Steel Building Products Ltd (MSBPL) is to perform certain procedure to design a safe and sound building. The main objective of this paper is

- Consideration of all loads that is required for a structure
- Selection of efficient and economic members to support the analysis

1.4 Source of Study

Although there were so many limitations, it was tried to use both the primary and secondary sources of collecting information to make the report presentable with as less abstraction as possible. For collecting the required data, I have used different sources or methods like the followings.

- Structural analysis software for 3D modeling and load application for analysis
- Latest and updated building codes

- Consultation of senior and experienced structural engineer
- Reference books, online articles, journals etc.

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1.4.1 Data Sources

For preparing the research paper both primary and secondary data have been used:

- Primary sources:
    - Client requirement of the project.
    - Architectural drawings and layout plans.
- Secondary Sources:
    - Type of loads based on the location of the project.
    - Information about the type of machineries whose loads should be considered.
    - Change of preliminary plans.

1.4.2 Data Preparation & Analysis Method

Data Preparation is the process of collecting data into from the client based on their requirement or as per suggestion of their assigned consultant.We have a form to prepare the date (PIF which stands for Project Information Form). Head of the design department then assign a particular project to one or a group of structural engineers. Preliminary meeting is held to analyze the data and we discuss the procedure of the project.

The process of data preparation typically involves:

- **Data Analysis –** Initial information of the project which includes location, dimensions, length, width, height of the building etc.
- **Preparing PIF** – Filling up the project information form for smooth operation and documentation.
- **Building Codes**– Preparing and documenting necessary load provisions for assigned project according to latest version of Bangladesh Nation Building Code (BNBC) and other necessary codes.

1.5 Limitation of the Study

Problems that I faced during the proposal phase are -

- Large scale research was not possible due to access constraints.
- Too much confidentiality.

- Lack of detailed and vast knowledge about structural analysis software.
- Lack of practical field experience.
- Lack of proper support from the factory for fabricating suitable structural members.

1.6 Organization of the Report

As a part of the MBA program, all students are required to complete three months' internship program or alternative submit a thesis paper. I have been assigned to submit a thesis paper. This report is the outcome of my assigned thesis paper.

The topic of my thesis is **"Structural Analysis and Design of Industrial Building in McDonald Steel Building Products Ltd (MSBPL)."**

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This papersurveystrendsinthe analysisand design ofsteel framed structureswithreference to design codessuchasthoseoftheBangladesh (BNBC 2006) , US(AISC,2011),theUK(BSI,2000). Thedevelopmentofdesigncodesreliesheavilyonexperienceandonthetheoreticalandexperimentalfindings of researchstudies.The steady andnowrapid increase in these hasledto significantexpansionsintheguidanceprovidedbycodes.Itisworthnotingthatanunexpectedconsequenceoft heseexpansionsisthatit becomesincreasingly more onerous to reviseand updatedesigncodes.

2.2 A TIMELINE FOR STEEL DESIGN CODES

Steel design codes in the 1930's were working stress codes in which the member stresses determined by analysing the structure under the working loads were required to be less than the permissible working stresses set out in the codes. Analysis of all but statically determinate frames (Figure 1) was difficult, because the established methods of indeterminate analysis were time consuming and error prone for many practical structures. Instead, approximate methods were used such as those which relied on assumed points of contra-flexure to render the structure statically determinate, or the moment distribution method developed by Hardy-Cross. Limited and relatively simple and sometimes empirical approximations were given for the permissible working stresses which made allowances for buckling, initial crookedness, and yielding, and incorporated factors of safety of the order of 2.

This situation continued until the 1960's, when plastic analysis and design were permitted. At this time, factors of safety were reduced, and more accurate expressions were used for the permissible working stresses which allowed for a wider range of restraint conditions for beams and columns which fail by buckling. The 1968 predecessor of SA (1998) allowed a method of design by buckling analysis in which the results of analyses for the elastic lateral buckling of beams could be used directly in determining the allowable stresses. Although computers were being used by researchers, they had little impact on designers.

The development of formulations for the permissible working stresses continued until the introduction of limit states design codes in the 1980's and 1990's, in which the analysis and design for strength moved from the working towards the ultimate load level. This required a more careful assessment of stability effects at these higher loads, and more accurate assessments of the strength design capacities of members and connectors.

The 1990 predecessor of SA (1998) contained a section which distinguished among the different types of analysis that were permitted, including first-order elastic analysis, amplified first-order analysis, second-order elastic analysis, and elastic buckling analysis, as well as plastic analysis. In doing so, the code recognized that designers were increasingly using computer methods of elastic analysis. It also recognized that design strength formulations could become more detailed, because the widespread use of computers would lead to these formulations being programmed, and even linked directly to computer analysis programs.

This predecessor also introduced the concept of advanced analysis, in which the previously separate activities of analysing the structure to determine the member actions and of designing suitable members to resist those actions was replaced by a single analysis of the structure which included all the effects that affect member strength.

Later codes have continued the process of making their member strength formulations more detailed.

2.3 PRESENT METHODS OF ANALYSIS AND DESIGN

2.3.1 METHODS OF STRUCTURAL ANALYSIS

In most methods of structural analysis, the distribution of forces and moments throughout the frame is determined by using the conditions of static equilibrium and of geometric compatibility between the members at the joints. The way in which this is done depends on whether a frame is statically determinate (in which case the complete distribution of forces and moments can be determined by statics alone), or is statically indeterminate (in which case the compatibility conditions for the deformed frame must also be used before the analysis can be completed).

A statically indeterminate frame can be analysed approximately if a sufficient number of assumptions are made about its behaviour to allow it to be treated as if determinate. One method of doing this is to guess the locations of points of zero bending moment and to assume there are frictionless hinges at a sufficient number of these locations that the member forces and moments can be determined by statics alone.

The accurate analysis of statically indeterminate frames is complicated by the interaction between members: the equilibrium and compatibility conditions and the constitutive relationships must all be used in determining the member forces and moments. There are a number of different types of analysis which might be made.

Figure 1. A structure designed manually

2.3.1.1 First-order elastic analysis

Forsomeframes,itiscommontouseafirst-orderelasticanalysiswhichisbasedonlinearelasticconstitutiverelationshipsandwhichignoresanygeometricalnon-linearitiesandassociatedinstabilityproblems(Figure2).Thedeformations$\{\Delta_1\}$determinedbysuchananalysis arerelatedtotheappliedloads$\{Q\}$throughthelinearrelationships(Figure 3)

$$[K]\{\Delta_1\}=\{Q\} \tag{1}$$

inwhich$[K]$isthestiffnessmatrix,andsotheprincipleofsuperpositioncanbeusedtosimplifytheanalysis.Itisoftenassumedthataxialandsheardeformationscanbeignoredinframeswhoseactionsarepredominantlyflexural,andthatflexuralandsheardeformationscanbeignoredinframeswhosememberforces are predominantlyaxial.

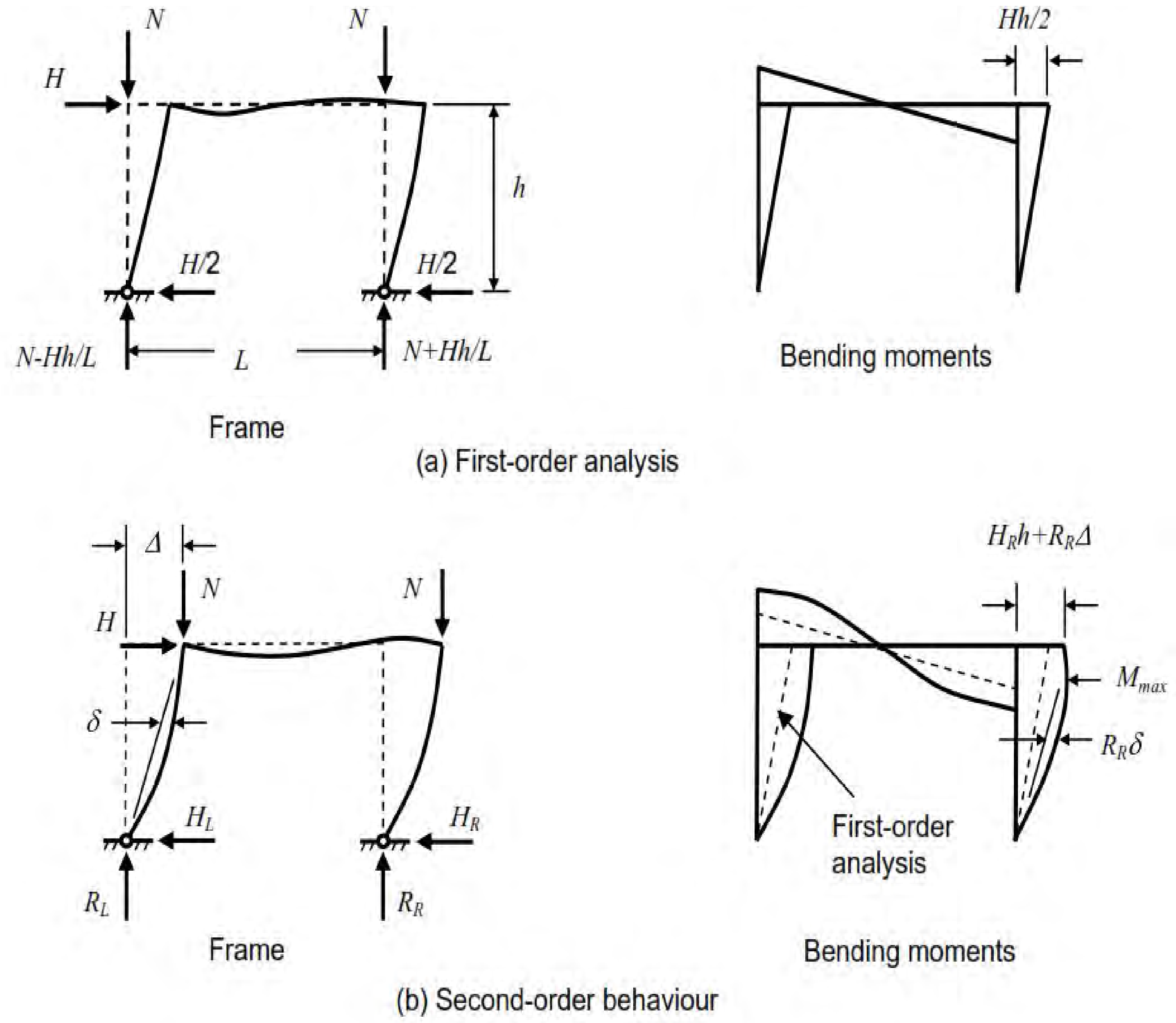


Figure 2. First-order analysis and second-order behaviour

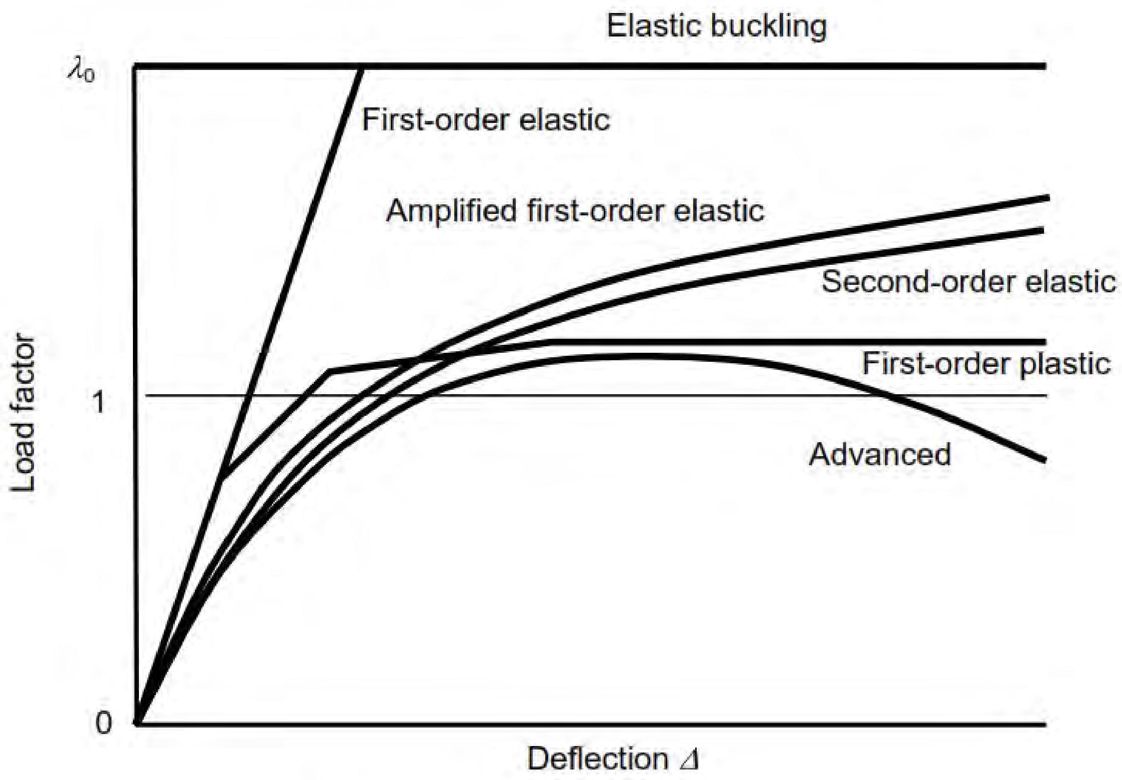


Figure 3. Methods of analysis

2.3.1.2 Elastic buckling analysis

However, a first-order elastic analysis will underestimate the forces and moments in and the deformations of a frame when instability effects are present. Some estimate of the importance of these can be obtained by making an elastic buckling analysis of the frame according to

$$\{\Delta_b\}^T [K - \lambda_0 G] \{\Delta_b\} = 0 \qquad (2)$$

in which λ_0 isthe buckling load factor and [G] is the stability matrix forthe initial forces.

2.3.1.3 Amplified first-order elastic analysis

More generally, the effects of instability must be allowed for, and as a first approximation the results of an elastic first-order analysis may be amplified by using factors derived from the frame elastic buckling loads (Figure 3), so that

$$\{\Delta_{1a}\} = \{\Delta_1\}/(1-1/\lambda_0) \qquad (3)$$

2.3.1.4 Second-order elastic analysis

Amoreaccurateallowancefortheeffectsofinstabilitymaybemadebyusinganelasticsecond-orderelasticanalysis (Figures 2,3), inaccordancewith

$$[K\text{-}G]\{\Delta_2\}=\{Q\} \quad (4)$$

Whilesomecodes(AISC,2011,SA,1998)allowsecond-orderanalysestobemadeofthenominalframe,others(BSI,2005,GHKSAR,2011)requiretheeffectsofgeometricalimperfections,residualstresses,andspreadofplasticitytobeallowedforapproximatelybyusingequivalentgeometricalimperfections{Δ_i}.Theshapeoftheseis usuallytaken to bethe same asthatof the lowestelasticbucklingmode{Δ_b} (Kindmann andKraus,2011), while the magnitude$\alpha_i$isdefined in thecode, so that

$$\{\Delta_i\}=\alpha_i\{\Delta_b\} \quad (5)$$

It is oftenconvenient to replace these equivalentimperfections byequivalent loads

$$\{Q_i\}=[K]\{\Delta_i\} \quad (6)$$

which inducefirst-orderdeformations equal tothe imperfections,whence

$$[K\text{-}G]\{\Delta_{2i}\}=\{Q+Q_i\} \quad (7)$$

2.3.1.5 Plastic analysis

The analysis of statically indeterminate frames near the ultimate load is further complicated by the decisive influence of the material non-linearities. Many two-dimensional (2D) frames have very small axial forces and instability effects, in which case it is comparatively easy to use a first-order plastic hinge analysis, according to which a sufficient number of plastic hinges must form to transform the frame into a collapse mechanism (Figure 3). The computational efficiency of the plastic hinge method is enhanced when the effects of geometrical non-linearities can be accurately allowed for by using one element per member (Chan and Zhou, 1995, 2000). Some attempts have been made to extend these plastic hinge methods to allow for semi-rigid rather than rigid joints between members (Nethercot, 1994, Yau and Chan, 1994).

Plastic zone analyses of 2D frames for which local and lateral buckling are prevented may allow for geometric (in-plane instability) and material (yielding) non-linearities, residual stresses, and geometrical imperfections, and account for the spread of the yielded zones through the cross-sections and along the members of the frames (Chan, 1989, Ho and Chan, 1993, Clarke, 1994). However, while this method is extremely accurate, it is computationally very complex, wasteful, and slow. Plastic zone methods have been used to develop benchmark solutions for testing the more efficient but less accurate plastic hinge methods (White and Chen, 1993, Liew et al, 1993, Yau and Chan, 1994, Chan and Chui, 2000, Liew et al, 2000), in which yielding effects are concentrated at a few cross-sections, and residual stress and geometrical imperfection effects are approximated by using reduced stiffnesses.

The plastic hinge method is simpler to use and computationally much more efficient than the plastic zone method. The results of the two methods are similar, except when the bending moment is nearly uniform with a wide spread of plasticity. In most practical cases, the plastic hinge method is considered to be adequate.

2.3.1.6 Advanced analysis

In advanced analysis (White and Chen, 1993, Clarke, 1994, Chen and Kim, 1997), the previously separate activities of analysing the frame to determine the member actions and of designing suitable members to resist those actions is replaced by a single analysis of the frame which includes all those effects that affect member strength such as local and lateral buckling, geometrical imperfections, residual stresses, and inelastic behaviour. It is then only necessary for the frame to reach a stable equilibrium position under the design loads for it to be deemed satisfactory (Figure 3).

For 2D frames for which local and lateral buckling are prevented, plastic hinge analyses which take account of in-plane stability and equivalent imperfections are equivalent to advanced analyses.

2.3.2 METHODS OF DESIGN

2.3.2.1 Design by code formulations

Present code methods of design provide formulations of the design strengths which are used to check the adequacy of the members and connections to resist the actions determined by the analysis of the frame. Of necessity, these are often limited in their application to the most common examples such as members of doubly symmetric cross-section. In some cases, the formulations (for beam-columns) are extremely complicated (BSI, 2005), while in others they are very simple (AISC, 2011).

2.3.2.2 Design by elastic buckling analysis

Somedesigncodes(SA,1998,BSI,2000,GHKSAR,2011)giveadviceontheeffectsofmomentdistribution,loadheight,andelasticrestraintsontheelasticlateralbucklingofbeamswhichissometimesofsomewhatdoubtfulaccuracy,especiallywithrespecttotheeffectsofloadheight,whileallcodesarelimitedintheamountofadviceonelasticbucklingthattheycangive.ThisdifficultyisavoidedinSA(1998),whichexplicitlyallowsthealternativemethodofdesignbyelasticbucklinganalysis(Trahairetal,2008)inwhichaccuratevaluesoftheelasticbucklingmomentM_0areuseddirectlyinthedesignprocesstodeterminethenominaldesigncapacityM_d.ThisallowscomputerprogramssuchasPRFELB(Papangelisetal,1993,1998)tobeusedtoobtainaccuratevaluesoftheelasticbucklingmomentM_0whichaccountproperlyfortheeffectsofmoment distribution, loadheight andendrestraints.
InSA(1998),thelateralbucklingdesignofbeamsisfoundedonabasicbeamdesigncurvewhichreducestheelasticbucklingmomentM_{0u}ofasimplysupportedbeaminuniformbending.Thisisachievedbyusingslenderness reduction factors

$$\alpha_s = 0.6\left\{\sqrt{\left[\left(\frac{M_s}{M_{0u}}\right)^2 + 3\right]} - \left(\frac{M_s}{M_{0u}}\right)\right\} \tag{8}$$

inwhich$M_s$isthesectionmomentcapacity,whichweredeterminedusingtheresultsoftestsonfull-scalememberswith practical values of residual stress and geometric imperfections(Trahairetal, 2008).

Inthemethodofdesignbyelasticbucklinganalysis,theactualelasticbucklingmomentM_0issubstitutedforthevalueM_{0u}forasimplysupportedbeaminuniformbending.Howeverthismethodisconservativebecauseit does notallow forthe effectsofthe momentdistribution on inelasticbuckling. This iscompensatedfor in SA(1998) by using a momentmodification factor

$$\alpha_m = M_{0s}/M_{0u} \tag{9}$$

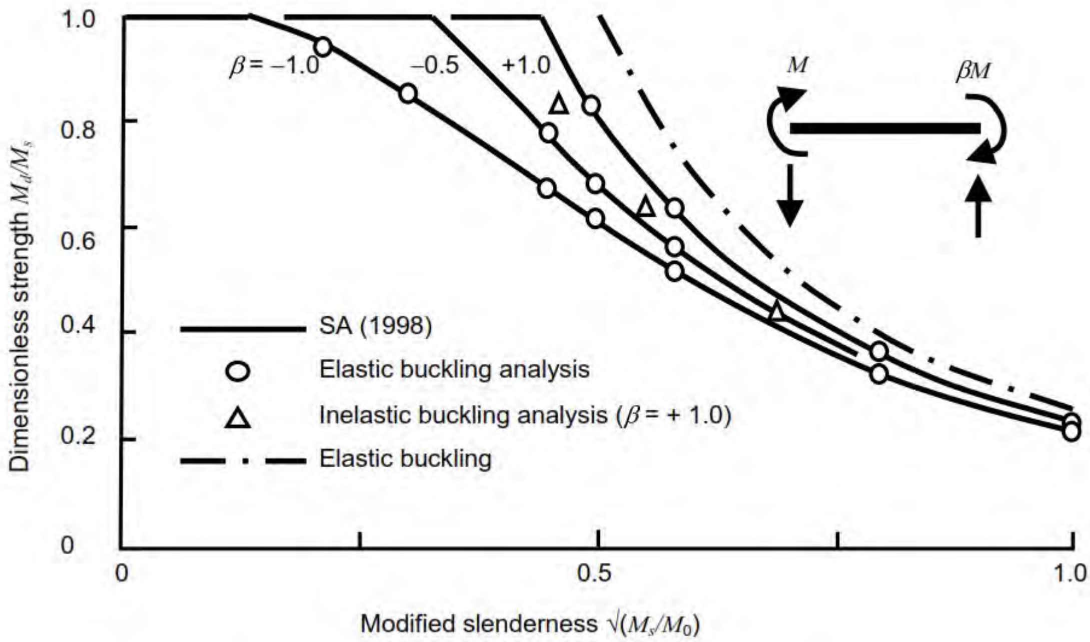


Figure 4. Buckling strengths of beams under moment gradient

inwhichM_{0u}istheelasticbucklingmomentofabeamwhichisunrestrainedagainstlateralrotationand loaded at the shear center.The nominaldesigncapacity is then determined from

$$M_d = \alpha_m \alpha_s M_s \leq M_s \quad (10)$$

The method of design by buckling analysis is demonstrated in Figure 4 for the example of the lateral buckling of simply supported beams under moment gradient.

The European code (BSI, 2005) gives no advice on elastic lateral buckling, but requires the direct use of M0 in the design process. This implicitly requires the use of the method of design by buckling analysis.

The method of design by elastic buckling analysis is also required by BSI (2005) for the design of compression members, while SA (1998) allows this method to be used for non-uniform compression members.

2.3.2.3 Out-of-plane design by inelastic buckling analysis

Inthecodemethodofout-of-planedesignbyelasticbucklinganalysis,theresultsofanelasticbucklinganalysiswhichincorporatestheeffectsofnon-uniformbending,loadheight,andelasticrestraintsareusedindeterminingslendernessreductionfactors,whichalsomakeallowancefortheeffectsofresidualstressesandgeometricalimperfections. However,thismethoddoesnotallowforthelocaleffectsofnon-uniformyieldingon the inelasticlateral bucklingresistance.

The inelastic out-of-planebucklingresistanceof a beamundernon-uniformbendingis significantlyaffectedbylocalreductionsintheout-of-planestiffnessesinthehighmomentregionsofthebeamwhereyieldingtakesplace.Becausethemomentdistributionvaries,sodothestiffnesses,andthebeambecomesnon-uniform.Toanalysethis,accountmustbetakenofthedistributionoftheelasticandinelasticregions bothinthecrosssections aswellas along the beam.

Onewaytoachievethisistousethemethodofmemberstrengthdesignbyinelasticbucklinganalysis(TrahairandHancock,2004)inwhichanelasticbucklinganalysisiscarriedwhichallowsforthelocaleffectsofnon-uniformyieldingontheout-of-planestiffnessesbyusingreducedmoduliγE,γG(TrahairandChan,2003).Theadvantageofthemethodisthatfiniteelementbucklinganalysisprogramssuchas PRFELB(Papangelis etal,1993,

1998) may be useddirectly without empirical adjustments of the results.

Thismethodhasbeentestedagainstcodeformulations(SA,1998)forthelateralbucklingstrengthsofbeamsundermomentgradient,beamswithcentralconcentratedloadsactingawayfromtheshearcentre,andbeamswithelasticendrestraints(TrahairandHancock,2004).Ithasalsobeenusedforcolumns,beam-columns(Trahair andHancock, 2004),frames (Trahair, 2009b),and cantilevers(Trahair, 2010b).

ThereducedelasticmoduliγE,γGusedintheelasticbucklinganalysistodetermineareducedbucklingmomentM_{0r}arederivedfromthenominallateralbucklingdesignstrengths$M_d$forsimplysupportedbeamsinuniformbending,andsoincludeallowancesfortheeffectsofyielding,residualstressesandgeometricalimperfections.Forbeamsinuniformbending,theresultantreducedmomentsM_{0r}areequaltothedesignmomentsM_d.

Thereducedmodulidecreaseasthebendingmomentincreases(Figure5),andsowhentheyareappliedtobeamswithnon-uniformmomentdistributions,therearegreaterreductionsinthehighmomentregionsandsmallerornoreductionsinthelowmomentregions.Themethodthustakesaccountoftheeffectofthemoment distribution oninelastic lateralbuckling.

Theresultsofusingthemethodofdesignbyinelasticbucklinganalysishasbeenusedtodeterminethe nominalSA (1998) design strengths$M_d = M_{0r}$of simply supported beams undermoment gradient areshown inFig.4.

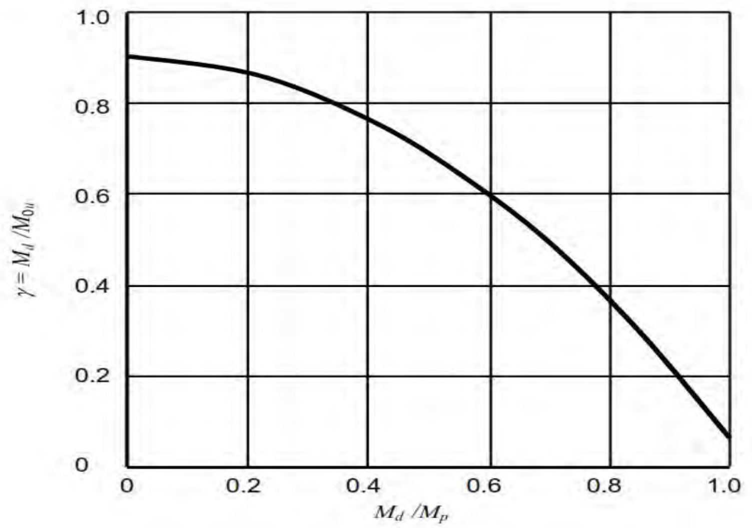


Figure 5. Reduced elastic moduli factors

2.4 SHORTCOMINGS IN CODE METHODS OF DESIGN

2.4.1 LOCAL BUCKLING STRENGTH

Code rules for local buckling strength are usually based on the behaviour of isolated plates, and while there are some approximations for allowing for the increased strengths that arise when the critical plate elements are restrained by others in the member cross-section, these are of somewhat doubtful accuracy.

2.4.2 COMPRESSION MEMBERS

While some code formulations of compression member strength already incorporate the results of elastic buckling analyses, there are many important situations that are not catered for, and so codes are generally inadequate in the advice that they give.

In some codes, the possibility of torsional or flexural-torsional buckling of compression members (Trahair, 1993) is not covered directly. For example, cruciforms may fail torsionally, while angles, tees and some channels are susceptible to flexural-torsional buckling. While the method of design by elastic buckling analysis in some codes allows the actual elastic buckling load to be used directly, this may sometimes lead to strength predictions which are overly conservative, as shown in Figure 6 (Trahair, 2012a).

Compression members are frequently braced eccentrically (Figure 7) or in planes which are inclined to their principal planes, leading to flexural-torsional buckling (Trahair and Rasmussen, 2005). The method of design by elastic buckling analysis may also be used in these cases.

Another shortcoming of some design codes is that they define rigid tolerances on compression member crookedness which prevent the use of overly crooked members (Figure 8), even when they are lightly loaded (Trahair and Kayvani, 2006).

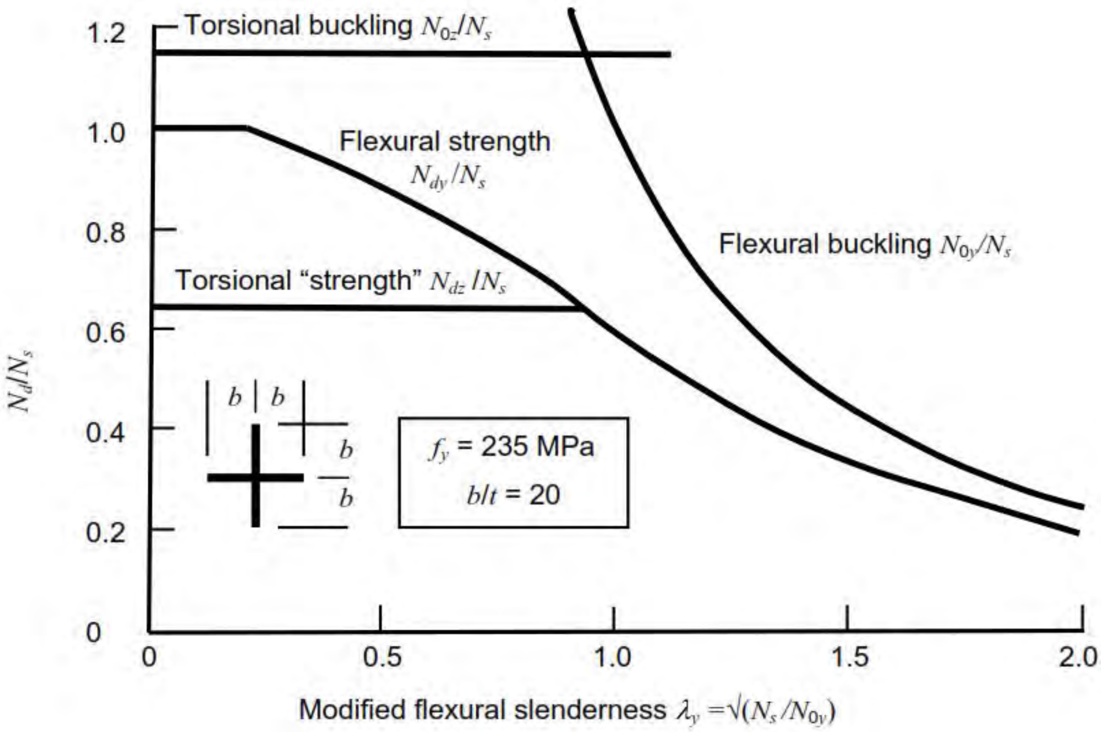


Figure 6. BSI (2005) design of cruciform columns

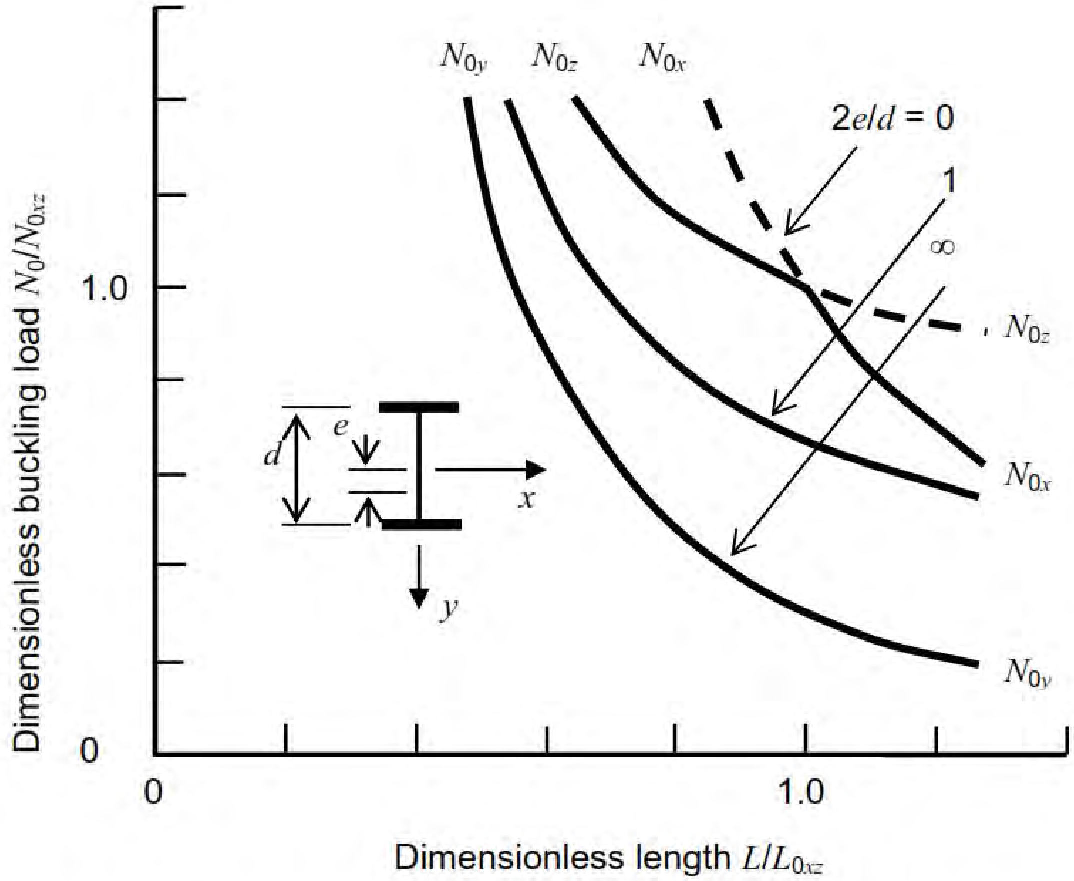


Figure 7. Buckling of columns with eccentric central restraints

2.4.3 BEAMS

Guidance given by codes for designing beams against lateral buckling is limited, extremely variable, and mainly based on the behaviour of doubly symmetric I-beams, which may be overly conservative for other beams such as rectangular hollow sections (Zhao et al, 1995a, Pi and Trahair, 1995), as shown in Figure 9.

There are a number of common effects that modify the strength, including the geometry, the moment distribution, the load height above the shear centre, and elastic restraints (Trahair, 1993). More consistent designs may be achieved by using the method of design by elastic buckling analysis, but this method alone does not allow for the strengthening effects of moment gradient on inelastic buckling (Figure 4). While some codes do make allowance for these, they are often unnecessarily conservative (BSI, 2005).

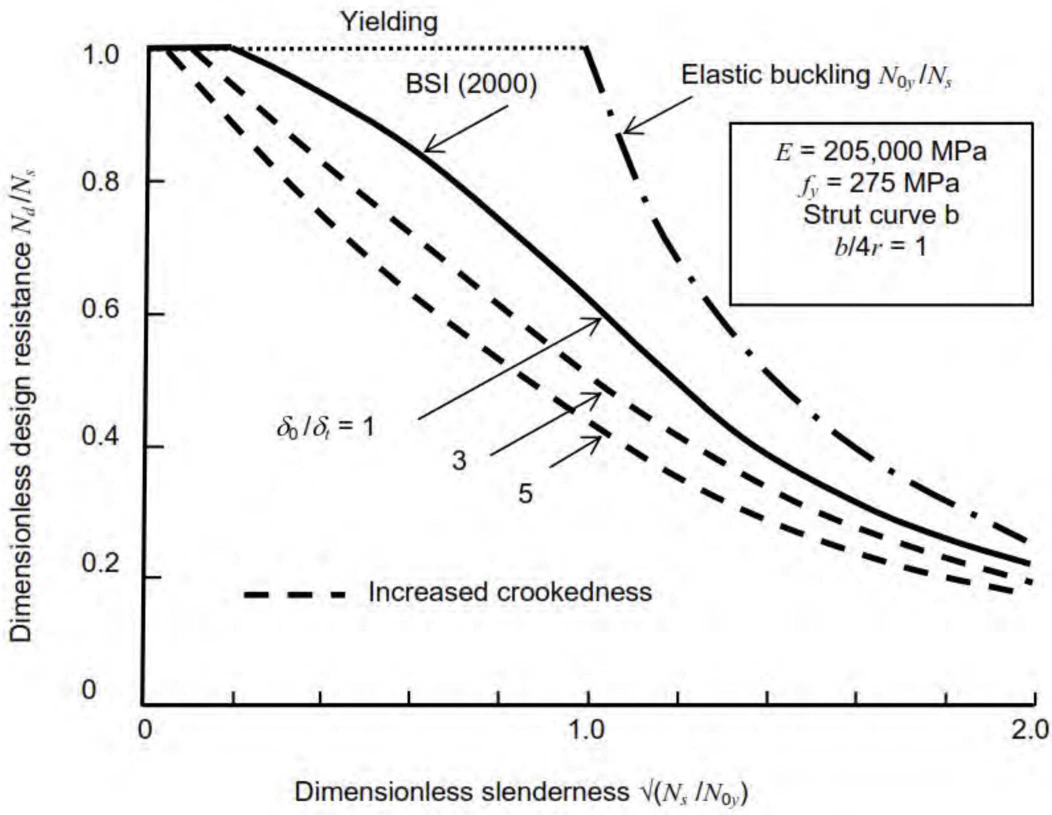


Figure 8. Design resistances of out-of-tolerance columns

Guidance given for the design of monosymmetric I-beams under moment gradient is often inaccurate, both in the elastic and the inelastic buckling ranges, as indicated in Figure 10 (Trahair, 2012b).

The effects of distortion on the strength of beams with slender webs are rarely covered, although the method of design by elastic buckling analysis has been used by substituting the elastic lateral-distortional buckling load for the elastic lateral buckling load. Distortion effects become important in continuous under-slung monorails, where the bottom flange cannot be restrained at intermediate supports, as shown in Figure 11 (Trahair, 2010a).

Angle section beams are frequently loaded in biaxial bending and torsion, but code rules do not adequately reflect this behaviour, and may give rise to variable strength predictions, as shown in Figure 12 (Trahair, 2009a).

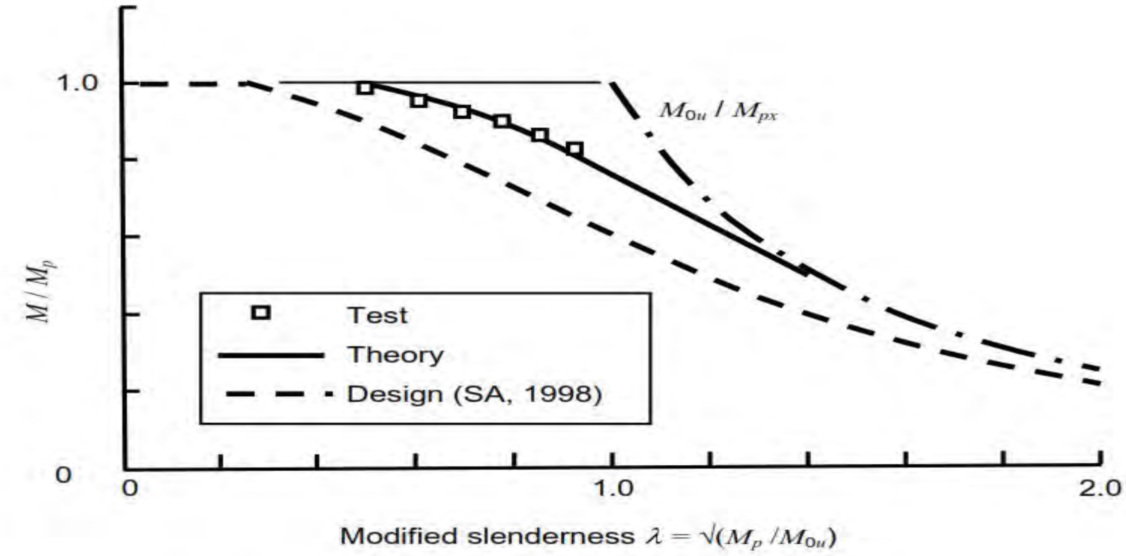


Figure 9. Lateral buckling strengths of RHS

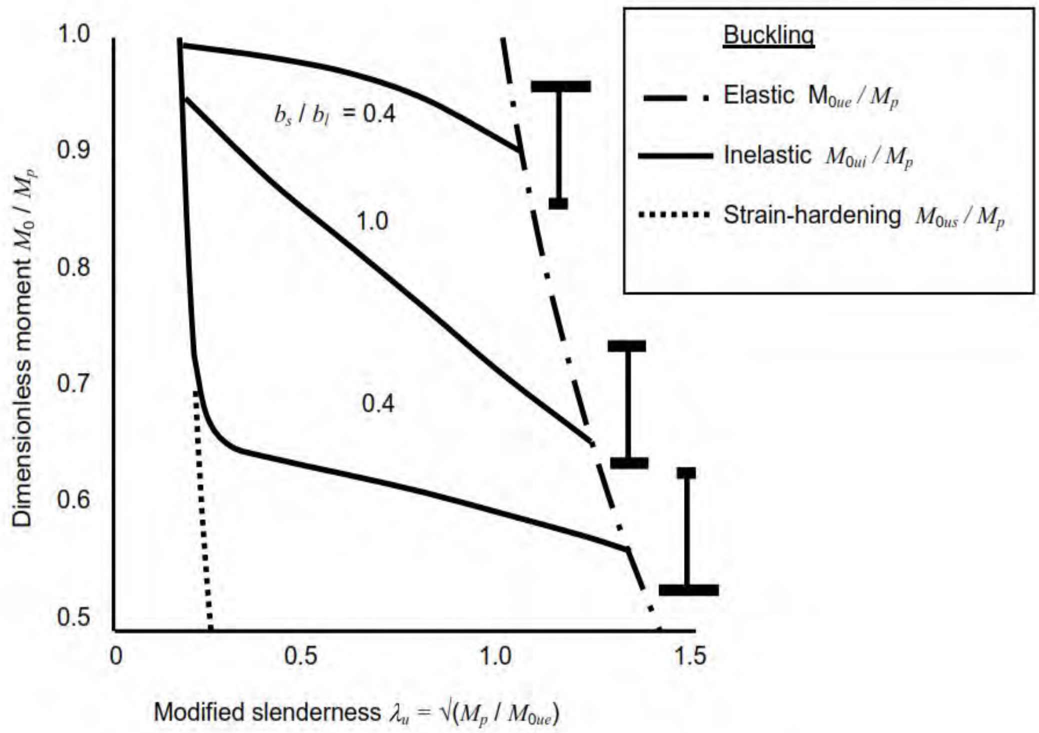


Fig. 10 Inelastic buckling of monosymmetric beams – uniform bending

2.4.4 BEAM-COLUMNS

The variety of different formulations for beam-column strength (BSI, 2005, AISC, 2011) suggests that there is a corresponding lack of accuracy in their predictions of strength. Some code formulations are excessively complicated, so that manual implementation is tedious and error prone.

2.4.5 BIAXIAL BENDING AND TORSION

Torsion and combined bending and torsion is largely neglected in steel design codes, even though there is a considerable body of knowledge of the former (Trahair et al, 2008), and some research studies (Pi and Trahair, 1994) of the latter.

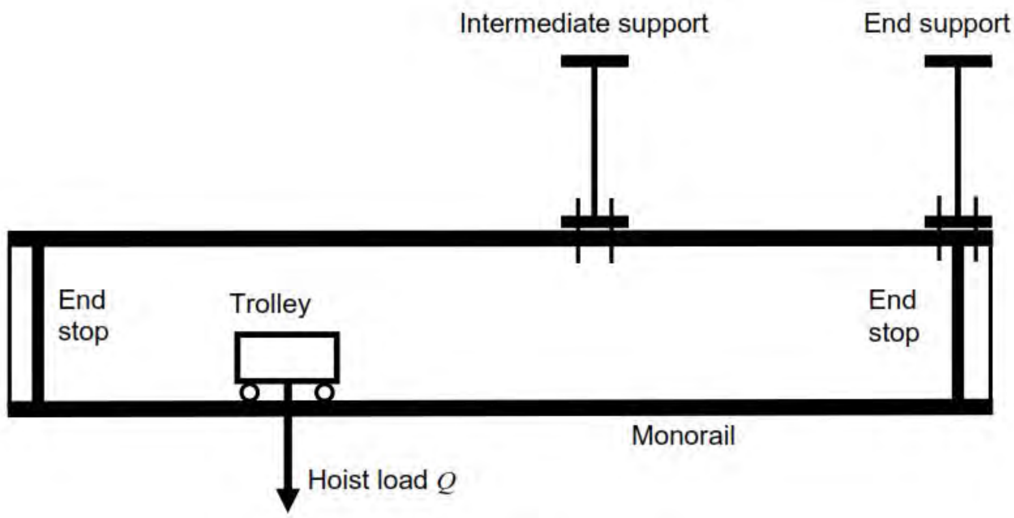


Figure 11 Overhanging monorail

2.5 FUTURE TREND

2.5.1 COMPUTER HARDWARE

Future analysis and design methods will be greatly influenced by further development of computer hardware and software. The expansion of storage capacity and increase in speed will allow more sophisticated structural analyses to be made of even larger structures, and will facilitate the efficient application of increasingly more complex code advice on member design. It is anticipated that future improvements in computer speed and storage will lead to practical methods of advanced analysis for a much wider range of applications than is now the case.

The advent of 64 bit multiple processors will lead to faster speeds and greatly increased storage capacities, so that there will be significant economies for large problems. To fully realize the potential of this, current software for 32 bit processors will need to be rewritten for 64 bits.

At the same time there will be further developments in user-friendly pre- and post-processors for the input of data and the display of results, while there will be even greater linking of computer programs for analysis, design, detailing, shop drawing and manufacture. However, there will be an even stronger need for checking procedures, since data errors will propagate through linked programs (Figure 13).

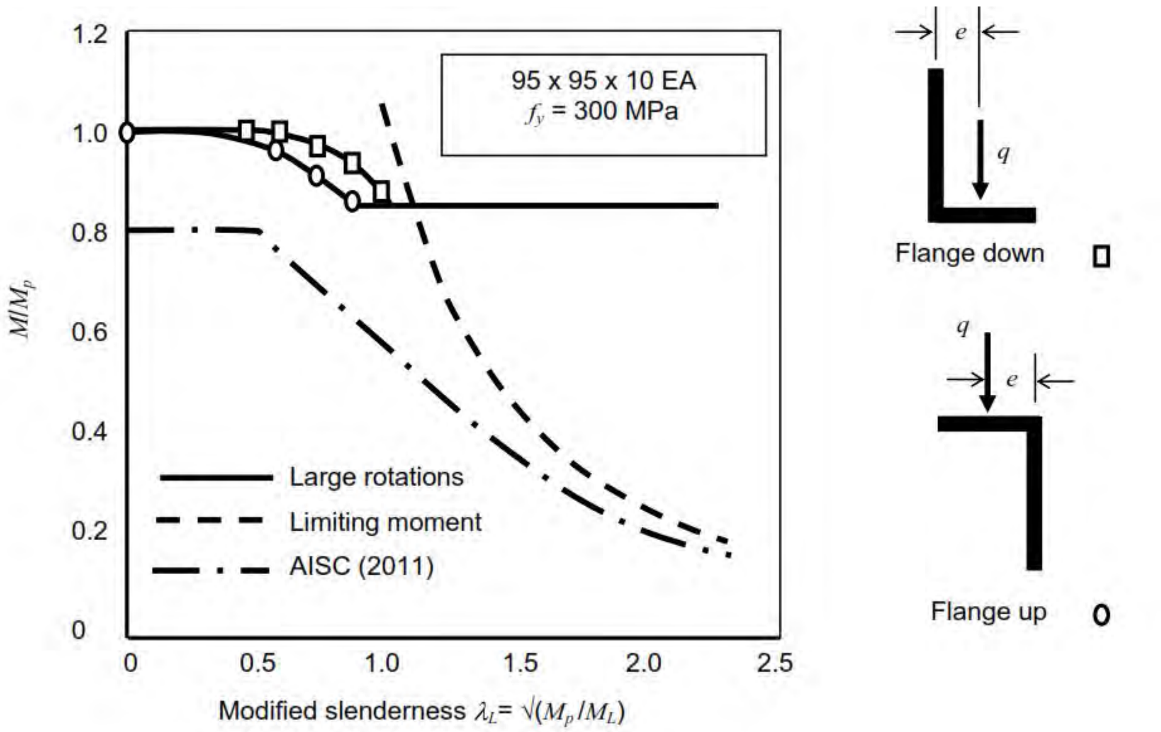


Figure 12. Uniformly loaded equal angle lintel

2.5.2 METHODS OF ANALYSIS

2.5.2.1 Advanced analysis

There have been a number of attempts to extend the method of advanced analysis of 2D frames with 2D loading to include the effects of local and out-of-plane buckling.

The accurate prediction of the local buckling effects requires the use of a finite element analysis which accounts for elastic buckling, yielding, out-of-flatness, residual stresses and post-buckling behaviour. The elements must be closely spaced with consequent sharp rises in computer storage and speed requirements. Thus the development of true advanced analyses for local buckling is likely to be delayed.

Similarly, the accurate prediction of out-of-plane strength also requires comparatively closely spaced elements (although perhaps not as closely as for local buckling, except in the case of monosymmetric sections).

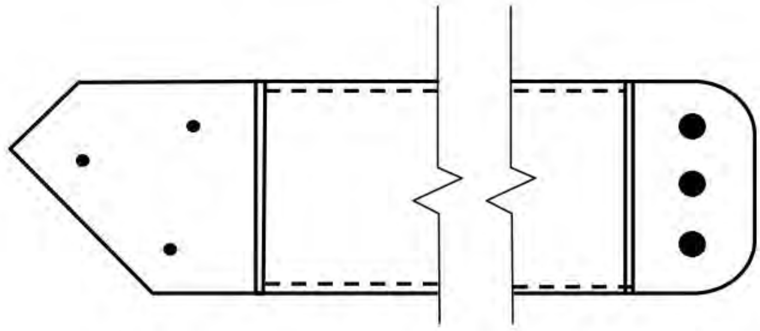


Figure 13 Computer transmission of errors

2.5.2.2 Analysis of biaxial bending and torsion

Methods of analysing biaxial bending and torsion are generally limited to first-order elastic analyses, and many of these omit the strengthening effects of warping torsion in open section members. Further difficulties arise when second-order effects must be allowed for.

2.5.3 METHODS OF DESIGN

The accurate prediction of local buckling effects on member strength requires the same use of a finite element analysis as that described above for advanced analysis. Again, the elements must be closely spaced with consequent sharp rises in computer storage and speed requirements.

Torsion and combined bending and torsion are largely neglected in steel design codes, while the design of arches and members curved in plan is not treated.

CHAPTER THREE

McDonald Steel Building Products Ltd

3.1 Background of McDonald Steel Building Products Ltd

McDonald Steel Building Products Limited (MSBPL) is the pioneer of Pre-fabricated structural steel construction in Bangladesh, having started its journey in 1998. Since then, MSBPL has been consistently developing quality steel solutions that have played an integral part in developing Bangladesh's infrastructure.

Equipped with world-class machinery and skilled engineers, McDonald Steel realizes unparalleled excellence in helping Bangladesh's growth story in pre-engineered steel building construction. MSBPL is poised to cater to a plethora of projects including power plants, multi-storey building construction, bridges, aviation hangars, etc.

Keeping pace with fast evolving construction techniques, in order to address aspects of speed, aesthetics and cost, we have chosen to incorporate automatic fabrication lines from Peddinghaus Corporation USA, Corimpex, Italy and Lincoln, USA and many other international brands.

We import and use the best quality products from Japan, Luxemburg, China and India. Quality is our committment and only McDonald steel in Bangladesh guarantees the best quality materials and fittings for your steel construction. We have successfully completed over 800 projects in Bangladesh and our clientele ranges from Government agencies to large local and international corporates

3.2 Motto of McDonald Steel Building Products Ltd

"Forge Ahead"

3.3 Vision of McDonald Steel Building Products Ltd

To sustain the leadership in pre-engineered steel building products in Bangladesh and upgrade the industry through our state-of-the-art technology, industry leading expertise and high quality support services.

3.4 Mission of McDonald Steel Building Products Ltd

- To continuously find ways to improve overall industry performance.
- To have respect for and understanding of the people with whom we work
- To maintain a high level of integrity and open communication in all our relationship
- To continuously look into innovation to develop the most effective solutions.

3.5Factory

Our factory has state-of-the-art workshops and is the first in Bangladesh to deliver pre-engineered building solutions. McDonald Steel produced hundreds of custom-made steel buildings each year through its ISO certified state-of-the-art manufacturing plants in Gazipur, Dhaka. The Gazipur facility alone has an annual capacity of 15,000 MT making it one of the most efficient facilities in the country.

McDonald Steel has the capability to engage in innovative metal fabrication solutions for all industries and project sizes requiring structural steel fabrication, miscellaneous metal fabrication, steel erection, mobile welding, design, manufacturing, project management, engineering technology, and drafting

3.6Client list

A short list of our valuable clients :

- United Group
- City Group
- KFC Restaurant
- Summit Group
- Power Pac Bangladesh
- Pepsi Cola (Transcom Beverage)
- S Alam Group
- Khulna Shipyard Ltd, Bangladesh
- Ha Meem Group
- British American Tobacco (BAT)
- Lakdhanavi Bangladesh Power
- IbnSina

- American International University Bangladesh (AIUB)
- Pran RFL Group
- Paramount Textile
- BRAC
- ACI
- Beximco Textiles
- Army Golf Club
- Gulshan Club Ltd
- Uttara Automobiles Ltd
- BOC Bangladesh Ltd
- Kurmitola Golf Club
- Pride Group
- Lotus Kamal Spinning Mills Ltd
- Islami Bank Foundation Hospital
- Kallol Group
- Jamuna Resort Ltd
- Monno Fabrics Ltd
- USHA Feed Ltd
- Singer Bangladesh Ltd
- Transcom Beverage Plant (Pepsi)
- Pran Dairy Ltd
- Berger Paint Bangladesh Ltd
- Fu Wang Group
- Home Bound Packer and Shipper
- Jamuna Bridge Project (All facilities Building)
- Mir Cement Ltd
- Nassa Group
- Navana Group
- Cemex Cement Bangladesh Ltd
- KYCR Coil Industries Ltd
- Seven Circle Ltd
- Khulna Medical College
- Danish Foods Ltd
- National Beverage Industries Ltd
- Noman Group
- Bay Footwear Ltd
- Givensee Group
- Meghna Group
- Paragon Enterprises Ltd
- Viyellatex
- J K Group
- QuasemDrycells Ltd
- Rahimafrooz Bangladesh
- Kohinoor Chemicals Ltd

- YKK Bangladesh
- Rangs Properties Ltd
- Asian Paints Bangladesh Ltd
- Ispahani Tea Ltd
- Ispahani Foods Ltd
- Jessore IT Park
- Franco German Embassy (National Development)
- Impress Group
- SenaKalyanSangstha, Bangladesh
- ISOLUX
- Far East Group

3.7JOINT VENTURE

A new Joint Venture Company named as "Nippon & McDonald Steel lndustries Limited [NMSIL]' has been formed under the agreement between McDonald Steel Building Products Limited [MSBPL] of Bangladesh and Nippon Steel &Sumikin Bussan Corporation [NSSB], Japan.

MSBPL is the pioneer in pre-engineered steel building construction in Bangladesh, experienced in Pre-Fabricated Steel Buildings for more than two[2] decades and established its own production facility in 1998. On the other hand, NSSB is the core trading company of the Nippon Steel & Sumitomo Metal Corporation Group, one of the world leading steel manufacturers.

NMSIL, the Joint Venture Company, is formed to operate a processing centre of FIat Products for manufacturing of processed 'Flat Products' and to carry out the business of Trading, Export, lmport, Supply of processed products, raw materials and related merchandise of world leading manufacturing company, in the region and beyond.

This partnership allows both the companies to build on each other's strength in line of related business.

3.8 PROJECT TYPES

The company produces a range of steel products for:

- Factory Buildings
- Warehouses
- Power Plant Shed

- Gymnasiums
- Poultry and Dairy Farms
- Cold Storages
- Railway Platform Shed
- Office and Residential Multi storied Buildings
- High Rise Shopping Centres
- Showrooms
- Supermarkets
- Distribution Centres
- Aircraft Hangers
- Exhibition Halls
- Labour Camps
- Entertainment Parks
- School and College
- Low cost housing
- Steel Mills
- Hospitals
- Diagnostic Centres
- Bridge Girders
- Water Towers
- Steel Platforms
- Steel Over Bridges
- Steel Stairs

3.9 STRENGTH

3.9.1 Best Possible Product

At McDonald Steel Building Products Ltd. (MSBPL), we produce quality products by using the best engineering software developed globally. Moreover, we have chosen the best and latest high-tech machinery to deliver high quality products to our customers. We have a highly experienced quality conscious workforce and maintain Quality Control (QC) operation at every stage of production. Our Quality Management System is compliant with the requirement of ISO-9001: 2000.

3.9.2 Professional Sales and Customer Service

Our customer oriented Sales Engineers are always at hand to attend to any queries with the utmost attention to details. The highly professional Customer Service Department minutely looks into each project to offer the most economical solution to clients' need. Proposals generated by McDonald's Sales & Customer Service Team fulfil customer requirements, as a truly professional offer is generated that not only contains competitive pricing but also includes detailed drawings so that customers get a true picture of the proposal for assessment at their end.

3.9.3 Expertise in Engineering

MSBPL has a host of qualified and professional engineers who have had years of experience in the construction business of the country.

3.9.4 Excellence in Team Work and Coordination

The Project Department ensures that smooth co-ordination is achieved between Sales, Engineering, Production Departments and customers. The co-ordination is done on a daily basis and starts from the point of sales till conclusion of building erection. This co-ordinated effort helps in smooth running of projects and keeping customers updated on the progress of their construction work.

3.9.5 Software and Design

We emphasize more on quality in design. We have our own licensed Software like STAAD-Pro, ETABS, TEKLA, SAP, Quick Series, which are widely used in our design section. We always try to procure latest design manuals for our designers. We have latest Steel Construction Manuals : AISC Steel Construction manual Vol-13, MBMA Metal Building System Manual, Edition 2002, AISI Structural Welding Code – Steel, Edition : 2006.

3.10 ADVANTAGE OF MSBPL

3.10.1 Safety Measures

Safety is a prime focus at MSBPL. Apart from following accepted industry standard safety measures in our factory, we religiously follow international safety codes in our structural designs as well. The structural steel design is done in accordance with BS 5950 part 1 and BS 5950 part 5/American codes/BNBC-93 and sometimes Australian Codes as well. The Loads are applied in accordance with BS 6399 loading of Building Part1: 1984: Code of practice for dead and imposed loads. Part2: BNBC/93 for wind and earthquake loading.

3.10.2 Health Safety

At MSBPL, health and safety issues are an integral part of our production process. Continuous improvement in health and safety performance at every level of the Company is our goal of Zero Harm to people.

The following beliefs form the basis for achieving our goal of Zero Harm:

- Working safety is a condition of employment
- Employee involvement is eventual
- The Management is accountable for safety performance
- All injuries can be prevented
- Training employees to work safely is essential
- All operating exposures can be safeguarded
- Despite all precaution, employees' health liability hospitalization insurance is ensured

3.10.3 Quality Control

Utilizing the latest computer software for design and detailing of pre-engineered and structural steel buildings, MSBPL provides the most competitive designs and the highest quality drawings - mostly within seven to ten days ensuring clear representation of customers' project requirements. This enables faster construction at site.

3.10.4 Strength in Delivery and Erection of Structure

Our structural steel division has the capability and capacity to supply structural steel buildings for any type of projects such as Desalination and Power Plants, Steel Mills, High Rises, Bridge Girders, Office Buildings, Factory Buildings, Water Towers, Steel Platforms and other complex structures.

In special cases where complex design is required for projects, like the petrochemical or oil and gas sector, we draw on the technical skills of world renowned experts in the field with whom we retain joint venture agreements.

3.10.5 Crane System

Our building can be designed to support any required crane system. Overhead traveling cranes of up to 15 metric tonnes are supported on brackets. Higher capacities are usually supported by an independent support system. Our quotations for buildings with crane systems usually include column or rafter brackets, crane runaway beams and bracings. We do require the customer's complete crane system information in order to design and estimate buildings with cranes.

3.10.6 Environment

- We care for the environment and place great importance on the way we manage the effect of our operations and products in our communities.
- We are committed to the efficient use of resources, reducing and preventing pollution and product stewardship, focusing on all aspects of the product lifecycle.
- Consistent Product Quality

3.10.7 Comprehensive Material Package

- Complete building shell
- Accessories

3.10.8 Cost Competitiveness

- Single source responsibility
- Reduced manpower and requirement needs
- Design flexibility
- Less time-consuming
- Architectural flexibility
- Highly adaptable for future expansion (during specification and erection)
- Engineering Capabilities
- Reduced Time frame
- Knowledge of local codes
- Knowledge of local construction methods
- Transportation Capabilities
- Dedicated transportation specialist for timely delivery.

CHAPTER FOUR

STRUCTURAL ANALYSIS AND DESIGN

4.1 Project Information Form (PIF)

We find the initial information of the project from PIF.

McDONALD STEEL BUILDING PRODUCTS LIMITED

Shanta Western Tower (Level-11), 186 Bir Uttam Mir Shawkat Ali Sarak, Tejgaon I/A, Dhaka-1208

Tel : 8878748-51 Fax : 880-2-8878752, e-mail : mcdnld@mcdonaldbd.com

CLIENT INFORMATION

Date :
Name of the Client :
Name of the Contact Person & Designation :
Address of the Client :
Date of Proposal Submission :
Contact Telephone No. :
Name of the Work / Project :
Description :

GEOMETRY of STRUCTURE

Length:	Width:
Eave Height :	Clear Height:
Height of Brick Wall :	Others:
Span:	Area :
Location of the project :	
Occupancy Category :	

LOAD DATA INFORMATION

Floor Loading		Lateral Loading			
Uniform Loading:		Wind Load Data		Seismic Load Data	
Concentric Loading:		Velocity:		Seismic Zonal Co-efficient Z :	
Machine Loading:		Exposure Category:		Seismic Performance Category:	○ OMRF ○ IMRF ○ SMRF
		Importance Factor:			

MATERIAL INFORMATION

Purlin :
Roof Sheet : Colorbond / Zincalume / Painted (Single / Double)
Wall Sheet : Colorbond / Zincalume / Painted (Single / Double)
Translucent Sheet : Yes / No (Roof / Wall)
Gutter : Yes / No
Down Pipe : Yes / No
Roof Projection : Yes / No (Length of Projection ....)
Door : Yes / No
Canopy : Yes / No (Size: .... , Nos :...)
Enamel paint : Yes / No (Size: .... , Nos :...)
Bubble Insulation / Glass wool insulation : Yes / No (Size: .... , Nos:...)
Steel Stair : Yes / No (Size: .... , Nos :...)
Roof Monitor : Yes / No (Size: .... , Nos :...)
Bondek : Yes / No (Size: .... , Nos :...)
Ventilation : Netural / Power Z Nos:...)

HOD(Structures & Detailing)   Marketing Person   Engineer in Charge

Fig 14 and 15: PIF of McDonald Steel Building Products Ltd.

4.2 Analysis and Design Software

We use StaadPro as our analysis and design software. After 3D modeling we assign load and load combinations. Modeling can be done in 2D also only for proposal/offer. But for working purpose, one must have a 3D model of the assigned project.

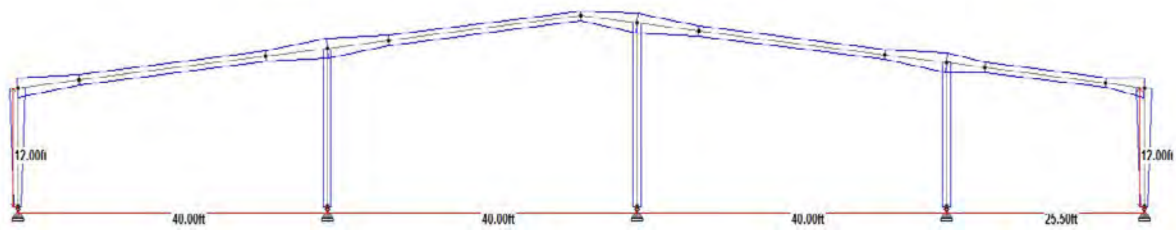


Fig 16: 2D Frame modeling with StaadPro v8i

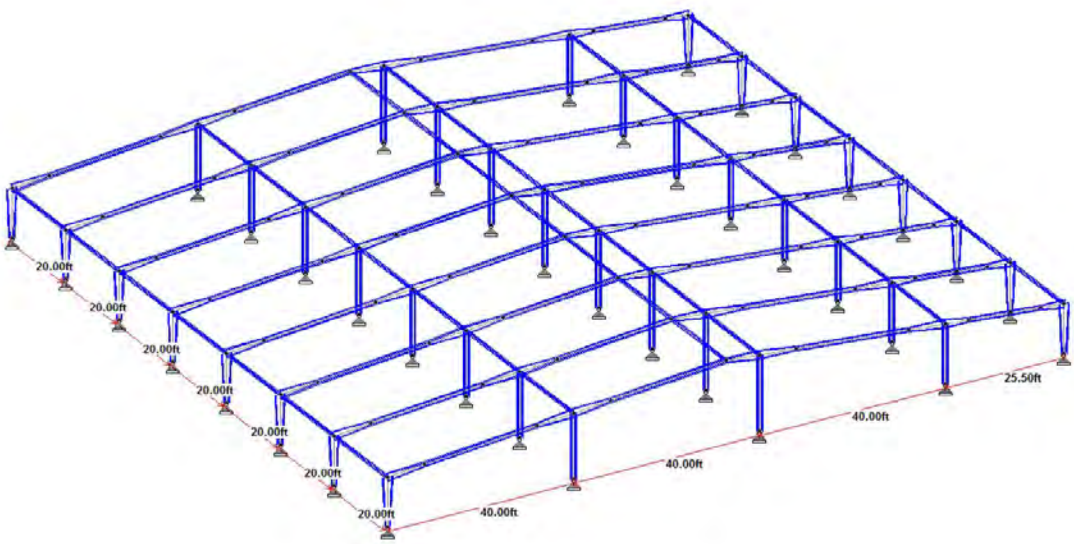


Fig 17: 3D Modeling with StaadPro v8i (Isometric view)

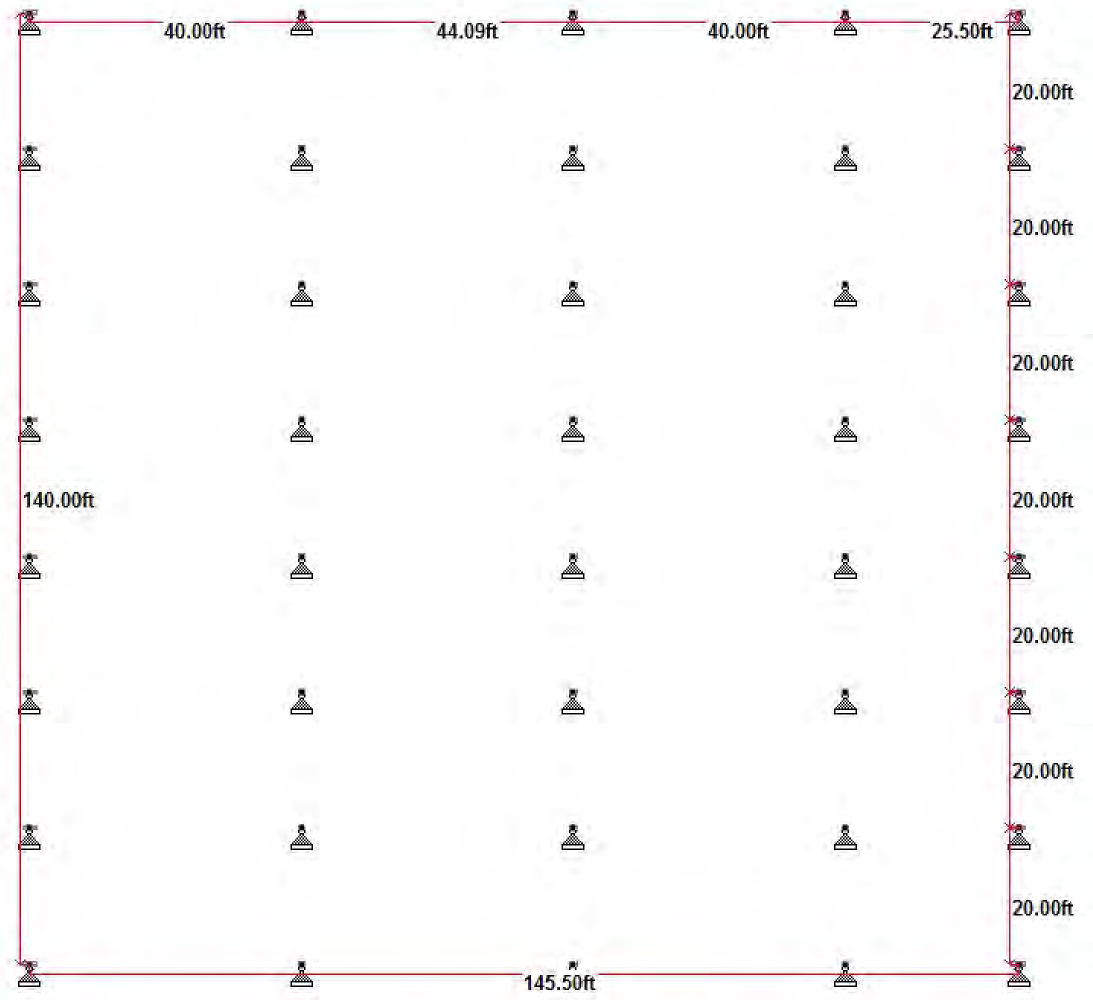


Fig 17: Column Layout

4.3 Loads and Load Combination

LOAD 1 LOADTYPE Seismic TITLE SLX

LOAD 2 LOADTYPE Seismic TITLE SL-X

LOAD 3 LOADTYPE Seismic TITLE SLZ

LOAD 4 LOADTYPE Seismic TITLE SL-Z

LOAD 5 LOADTYPE Wind TITLE WLX

LOAD 6 LOADTYPE Wind TITLE WL-X

LOAD 7 LOADTYPE Wind TITLE WLZ

LOAD 8 LOADTYPE Wind TITLE WL-Z

LOAD 9 LOADTYPE Dead TITLE DL

LOAD 10 LOADTYPE Dead TITLE LL

LOAD COMB 11 DL+LL

9 1.0 10 1.0

LOAD COMB 12 DL+SLX

1 1.0 9 1.0

LOAD COMB 13 DL+SL-X

2 1.0 9 1.0

LOAD COMB 14 DL+SLZ

3 1.0 9 1.0

LOAD COMB 15 DL+SL-Z

4 1.0 9 1.0

LOAD COMB 16 DL+WLX

5 1.0 9 1.0

LOAD COMB 17 DL+WL-X

6 1.0 9 1.0

LOAD COMB 18 DL+WLZ

7 1.0 9 1.0

LOAD COMB 19 DL+WL-Z

8 1.0 9 1.0

LOAD COMB 20 0.9DL+SLX

1 1.0 9 0.9

LOAD COMB 21 0.9DL+SL-X

2 1.0 9 0.9

LOAD COMB 22 0.9DL+SLZ

3 1.0 9 0.9

LOAD COMB 23 0.9DL+SL-Z

4 1.0 9 0.9

LOAD COMB 24 0.9DL+WLX

5 1.0 9 0.9

LOAD COMB 25 0.9DL+WL-X

6 1.0 9 0.9

LOAD COMB 26 0.9DL+WLZ

7 1.0 9 0.9

LOAD COMB 27 0.9DL+WL-Z

8 1.0 9 0.9

LOAD COMB 28 DL+LL+SLX

1 1.0 9 1.0 10 1.0

LOAD COMB 29 DL+LL+SL-X

2 1.0 9 1.0 10 1.0

LOAD COMB 30 DL+LL+SLZ

3 1.0 9 1.0 10 1.0

LOAD COMB 31 DL+LL+SL-Z

4 1.0 9 1.0 10 1.0

LOAD COMB 32 DL+LL+WLX

5 1.0 9 1.0 10 1.0

LOAD COMB 33 DL+LL+WL-X

6 1.0 9 1.0 10 1.0

LOAD COMB 34 DL+LL+WLZ

7 1.0 9 1.0 10 1.0

LOAD COMB 35 DL+LL+WL-Z

8 1.0 9 1.0 10 1.0

4.4 Completion of Design and Preparing Final Report

After completion of analysis and design, we have to prepare a final report which we submit to our clients upon request or for documentation only.

4.4.1 Report of Echotex

Echotex is a garments company. Design report of Echotex is attached below which was prepared by me:

Objective of the report:

This report has been prepared in favor of Echotex Ltd. for detailed engineering assessment of existing Printing Building.

Scope of the report:

Scopes are:

01. Detailed Engineering Assessment of existing steel structure of Printing Building
02. Preparation of as built structural & architectural drawings.

Design Consideration for structural Analysis:

1	Design Dead Load (kN/m^2)	Self weight of structure
2	Design Live Load (kN/m^2) on Roof	0.57
3	Design Live Load (kN/m^2) on Floors	2.0
4	Material Strenght	All Structural element : 345Mpa
5	Wind Speed (kph)	215kph, except for roof extension in between grid 09 and 10 where wind speed is 100 kph.
6	Wind Exposure	A
7	Additional Collateral Load (kN/m^2)	None
8	Load combination	As per BNBC(LRFD)
9	Structural Importance Co-efficient	1
10	Lateral Support	Purlin on roof, Cable Bracing on roof and R.C.C. Slab on mezzanine floors.
11	Unbraced Length	Rafter: Purlin Spacing(Purlin cleat for top flange and stress bar for bottom flange) for Rafter Secondary Beams: Shear Bolt Spacing (Shear bolts welded to the top flange of secondary beams)
12	Codes	1) **Bangladesh National Building Code 2006** *Published by:* Housing and Building Research Institute Darus-Salam, Mirpur, Dhaka-1218 and Bangladesh Standards and Testing Institution 116/A BSCIC Industrial Area, Dhaka-1208. 2) **Steel Construction Manual (2005)** Thirteenth Edition

		American Institute of Steel Construction Inc. **(AISC)** One East Wacker Drive, Suite 700 Chicago, IIIinois60601-1802, USA 3) **International Building Code "IBC".** 2006 Edition International Code Council, Inc. 4051 West Flossmoor, Country Club Hills, IL 60478-5795 Phone: (001-800) 214 4321 • Fax: (001-800) 214 7167• Web site: www.iccsafe.org 4) **Metal Building Systems Manual** 2002 Edition MetalBuilding Manufacturers Association **(MBMA)** 1300 Summer Avenue Cleveland, Ohio44115

Project Pictures:

Google Map View


GATE #2 BUILDING #3
CCTV IN OPERATION

STAAD.ProReport(AS built Condition)

Job Information

	Engineer	Checked	Approved
Name:			
Date:	31-Jan-16		

Structure Type SPACE FRAME

Number of Nodes	335	Highest Node	413
Number of Elements	575	Highest Beam	807
Number of Plates	25	Highest Plate	788

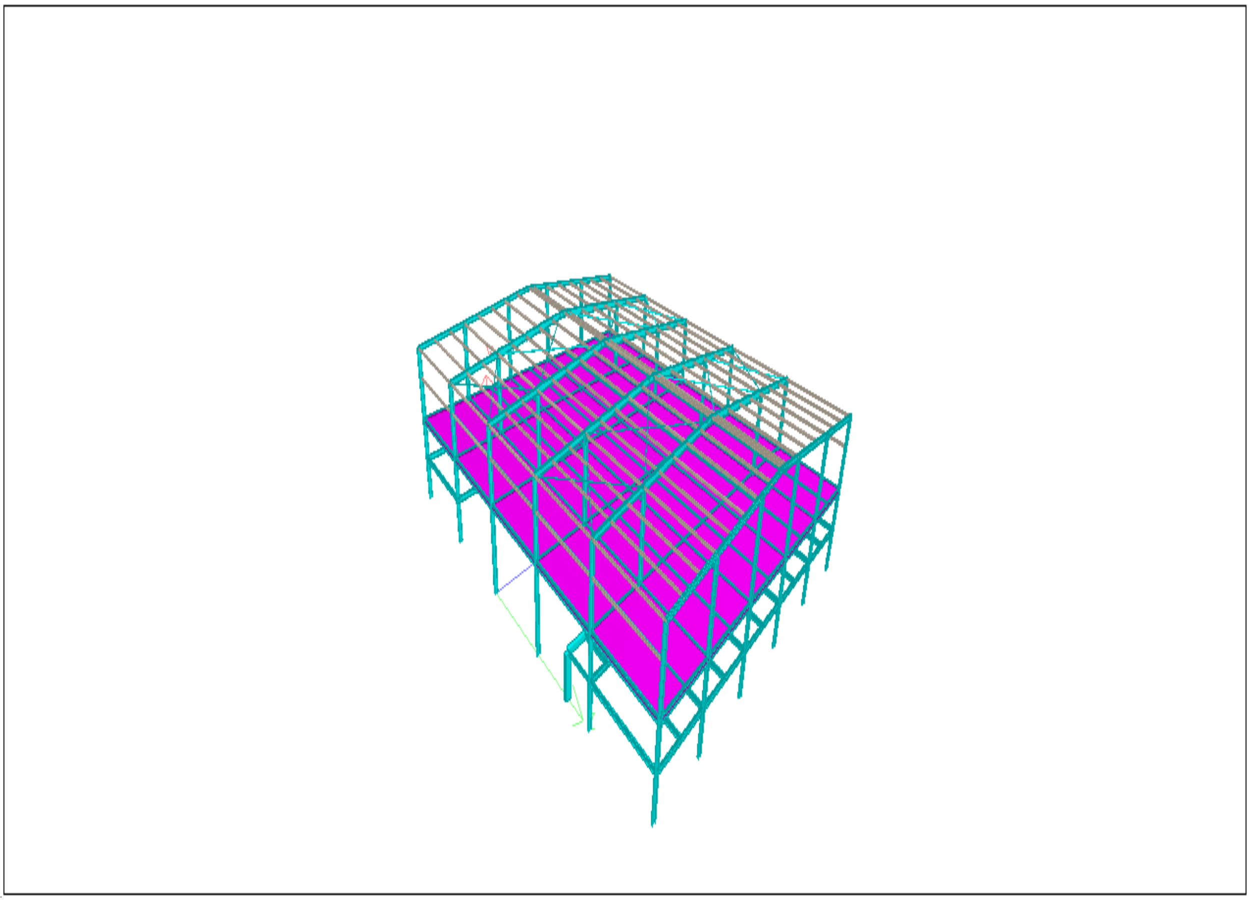
Number of Basic Load Cases	-2
Number of Combination Load Cases	18

Included in this printout are data for:

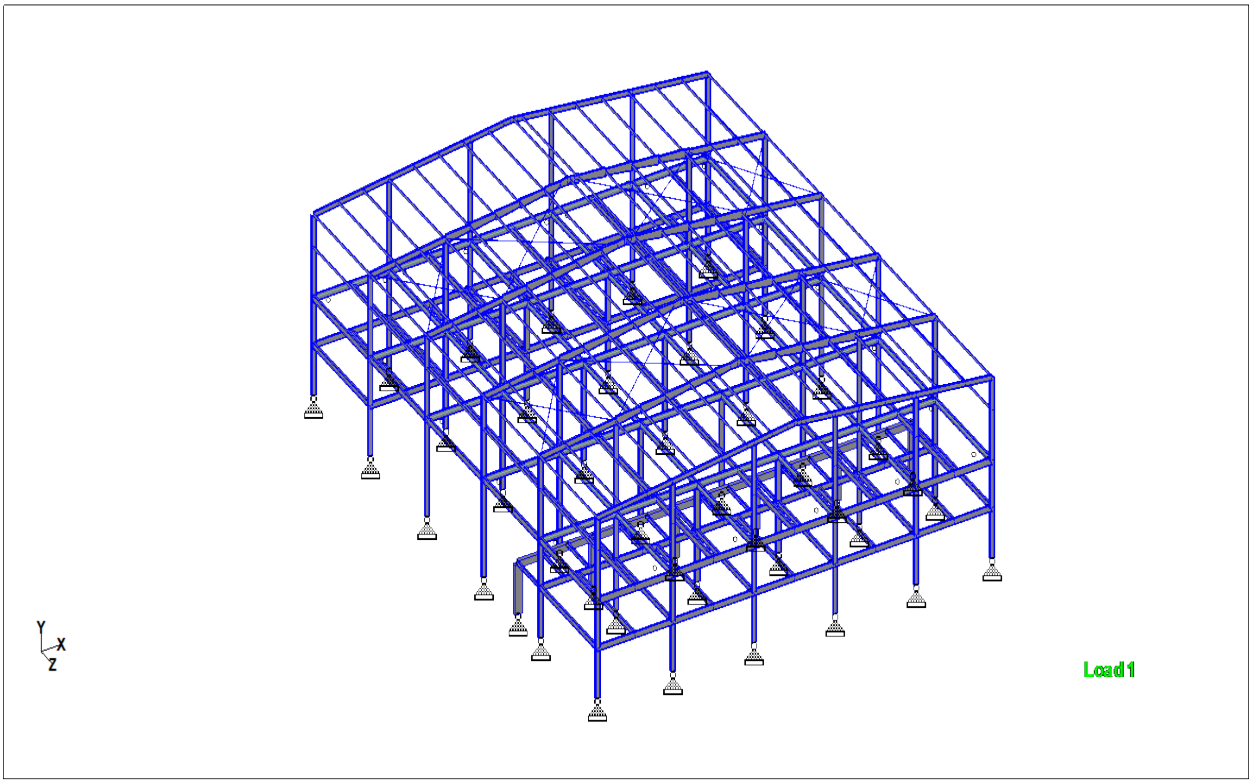
All The Whole Structure

Included in this printout are results for load cases:

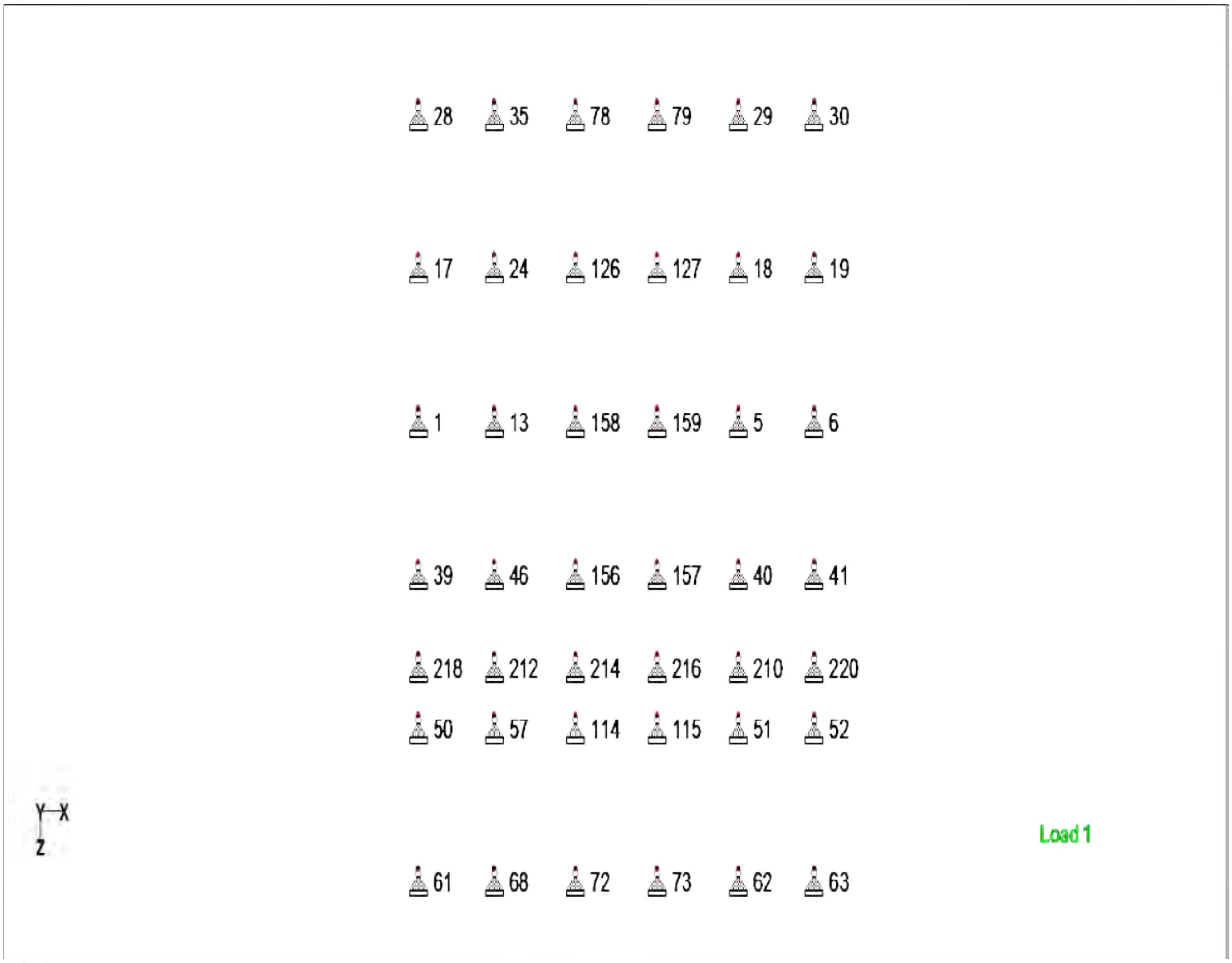
Type	L/C	Name
Primary	1	EQ X+
Primary	2	EQ X-
Primary	3	EQ Z+
Primary	4	EQ Z-
Primary	5	WL X+
Primary	6	WL X-
Primary	7	WL Z+
Primary	8	WL Z-
Primary	9	DL
Primary	10	LL R
Primary	11	LL F
Combination	12	1.4DL
Combination	13	1.2D+1.6LLF+0.5LLR
Combination	14	1.2D+1.3W X+0.5LF+0.5LR
Combination	15	1.2D+1.3W X- +0.5LF+0.5LR
Combination	16	1.2D+1.3W Z+0.5LF+0.5LR
Combination	17	1.2D+1.3W Z- +0.5LF+0.5LR
Combination	18	1.2D+1.5EX+.5LF
Combination	19	1.2D+1.5EX- +.5LF
Combination	20	1.2D+1.5EZ+.5LF
Combination	21	1.2D+1.5EZ- +.5LF
Combination	22	0.9D+1.5EQ X+
Combination	23	0.9D+1.5EQ X-
Combination	24	0.9D+1.5EQ Z+
Combination	25	0.9D+1.5EQ Z-
Combination	26	0.9D+1.3WL X+
Combination	27	0.9D+1.3WL X-
Combination	28	0.9D+1.3WL Z+
Combination	29	0.9D+1.3WL Z+



3D Rendered View



Whole Structure



Whole Structure

Utilization Ratio

Beam	**Analysis** Property	**Design** Property	**Actual** Ratio	**Allowable** Ratio	**Ratio** (Act./Allow.)	**Clause**
1	Taper	Taper	1.542	1.000	1.542	LRFD-H1-1A-C
2	Taper	Taper	1.493	1.000	1.493	LRFD-H1-1A-C
3	Taper	Taper	0.084	1.000	0.084	LRFD-H1-1B-T
4	Taper	Taper	0.081	1.000	0.081	LRFD-H1-1B-T
6	Taper	Taper	3.652	1.000	3.652	LRFD-H1-1A-C
7	Taper	Taper	0.998	1.000	0.998	LRFD-H1-1B-T
8	Taper	Taper	0.720	1.000	0.720	LRFD-H1-1B-T
9	Taper	Taper	3.611	1.000	3.611	LRFD-H1-1A-C
10	Taper	Taper	0.759	1.000	0.759	LRFD-H1-1B-T
11	Taper	Taper	0.671	1.000	0.671	LRFD-H1-1B-T
19	Taper	Taper	0.736	1.000	0.736	LRFD-H1-1A-C
20	Taper	Taper	0.817	1.000	0.817	LRFD-H1-1A-C
21	Taper	Taper	0.089	1.000	0.089	LRFD-H1-1B-T
22	Taper	Taper	0.089	1.000	0.089	LRFD-H1-1B-T
23	Taper	Taper	1.210	1.000	1.210	LRFD-H1-1A-C
24	Taper	Taper	0.997	1.000	0.997	LRFD-H1-1B-T
25	Taper	Taper	0.722	1.000	0.722	LRFD-H1-1B-T
26	Taper	Taper	1.217	1.000	1.217	LRFD-H1-1A-C
27	Taper	Taper	0.676	1.000	0.676	LRFD-H1-1B-T
28	Taper	Taper	0.705	1.000	0.705	LRFD-H1-1B-T
36	Taper	Taper	0.623	1.000	0.623	LRFD-H1-1A-C
37	Taper	Taper	0.602	1.000	0.602	LRFD-H1-1A-C
38	Taper	Taper	0.090	1.000	0.090	LRFD-H1-1B-C
39	Taper	Taper	0.100	1.000	0.100	LRFD-H1-1B-C
40	Taper	Taper	1.504	1.000	1.504	LRFD-H1-1A-C
41	Taper	Taper	0.228	1.000	0.228	LRFD-H1-1B-T
42	Taper	Taper	0.193	1.000	0.193	LRFD-H1-1B-T
43	Taper	Taper	1.511	1.000	1.511	LRFD-H1-1A-C
44	Taper	Taper	0.122	1.000	0.122	LRFD-H1-1B-T
45	Taper	Taper	0.129	1.000	0.129	LRFD-H1-1B-T
53	Taper	Taper	1.421	1.000	1.421	LRFD-H1-1A-C
54	Taper	Taper	1.522	1.000	1.522	LRFD-H1-1A-C
55	Taper	Taper	0.083	1.000	0.083	LRFD-H1-1B-T
56	Taper	Taper	0.073	1.000	0.073	LRFD-H1-1B-T
57	Taper	Taper	3.674	1.000	3.674	LRFD-H1-1A-C
58	Taper	Taper	0.997	1.000	0.997	LRFD-H1-1B-T
59	Taper	Taper	0.720	1.000	0.720	LRFD-H1-1B-T
60	Taper	Taper	3.676	1.000	3.676	LRFD-H1-1A-C
61	Taper	Taper	0.697	1.000	0.697	LRFD-H1-1B-T
62	Taper	Taper	0.723	1.000	0.723	LRFD-H1-1B-T
70	Taper	Taper	0.922	1.000	0.922	LRFD-H1-1A-C
71	Taper	Taper	0.953	1.000	0.953	LRFD-H1-1A-C
72	Taper	Taper	0.074	1.000	0.074	LRFD-H1-1B-C
73	Taper	Taper	0.085	1.000	0.085	LRFD-H1-1B-C
74	Taper	Taper	1.124	1.000	1.124	LRFD-H1-1A-C
75	Taper	Taper	0.996	1.000	0.996	LRFD-H1-1B-T
76	Taper	Taper	0.722	1.000	0.722	LRFD-H1-1B-T
77	Taper	Taper	1.130	1.000	1.130	LRFD-H1-1A-C
78	Taper	Taper	0.760	1.000	0.760	LRFD-H1-1B-T
79	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-T
87	Taper	Taper	0.756	1.000	0.756	LRFD-H1-1B-C
88	Taper	Taper	0.753	1.000	0.753	LRFD-H1-1B-C
89	Taper	Taper	0.092	1.000	0.092	LRFD-H1-1B-C
90	Taper	Taper	0.099	1.000	0.099	LRFD-H1-1B-C
91	Taper	Taper	1.393	1.000	1.393	LRFD-H1-1A-C

92	Taper	Taper	0.228	1.000	0.228	LRFD-H1-1B-T
93	Taper	Taper	0.194	1.000	0.194	LRFD-H1-1B-T
94	Taper	Taper	1.391	1.000	1.391	LRFD-H1-1A-C
95	Taper	Taper	0.187	1.000	0.187	LRFD-H1-1B-T
96	Taper	Taper	0.202	1.000	0.202	LRFD-H1-1B-T
97	Taper	Taper	1.537	1.000	1.537	LRFD-H1-1A-C
98	Taper	Taper	1.539	1.000	1.539	LRFD-H1-1A-C
99	Taper	Taper	0.279	1.000	0.279	LRFD-H1-1B-T
100	Taper	Taper	0.297	1.000	0.297	LRFD-H1-1B-T
101	Taper	Taper	1.557	1.000	1.557	LRFD-H1-1A-C
102	Taper	Taper	1.557	1.000	1.557	LRFD-H1-1A-C
103	Taper	Taper	0.296	1.000	0.296	LRFD-H1-1B-T
105	Taper	Taper	0.330	1.000	0.330	LRFD-H1-1B-T
106	Taper	Taper	0.735	1.000	0.735	LRFD-H1-1B-C
107	Taper	Taper	1.229	1.000	1.229	LRFD-H1-1A-C
108	Taper	Taper	0.697	1.000	0.697	LRFD-H1-1B-T
109	Taper	Taper	1.373	1.000	1.373	LRFD-H1-1A-C
110	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
111	Taper	Taper	1.375	1.000	1.375	LRFD-H1-1A-C
112	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
113	Taper	Taper	1.228	1.000	1.228	LRFD-H1-1A-C
114	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
115	Taper	Taper	0.728	1.000	0.728	LRFD-H1-1B-C
116	Taper	Taper	0.697	1.000	0.697	LRFD-H1-1B-T
117	Taper	Taper	0.818	1.000	0.818	LRFD-H1-1B-C
118	Taper	Taper	0.422	1.000	0.422	LRFD-H1-1B-T
119	Taper	Taper	3.288	1.000	3.288	LRFD-H1-1A-C
120	Taper	Taper	0.439	1.000	0.439	LRFD-H1-1B-T
121	Taper	Taper	0.869	1.000	0.869	LRFD-H1-1B-C
122	Taper	Taper	0.954	1.000	0.954	LRFD-H1-1A-C
123	Taper	Taper	0.422	1.000	0.422	LRFD-H1-1B-C
124	Taper	Taper	1.339	1.000	1.339	LRFD-H1-1A-C
125	Taper	Taper	0.696	1.000	0.696	LRFD-H1-1B-T
126	Taper	Taper	1.385	1.000	1.385	LRFD-H1-1A-C
127	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
128	Taper	Taper	1.387	1.000	1.387	LRFD-H1-1A-C
129	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
130	Taper	Taper	1.339	1.000	1.339	LRFD-H1-1A-C
131	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
132	Taper	Taper	0.838	1.000	0.838	LRFD-H1-1B-C
133	Taper	Taper	0.697	1.000	0.697	LRFD-H1-1B-T
134	Taper	Taper	0.955	1.000	0.955	LRFD-H1-1A-C
135	Taper	Taper	0.422	1.000	0.422	LRFD-H1-1B-C
136	Taper	Taper	0.865	1.000	0.865	LRFD-H1-1A-C
137	Taper	Taper	0.422	1.000	0.422	LRFD-H1-1B-C
138	Taper	Taper	3.304	1.000	3.304	LRFD-H1-1A-C
139	Taper	Taper	0.439	1.000	0.439	LRFD-H1-1B-T
140	Taper	Taper	3.171	1.000	3.171	LRFD-H1-1A-C
141	Taper	Taper	0.552	1.000	0.552	LRFD-H1-1B-T
142	Taper	Taper	3.165	1.000	3.165	LRFD-H1-1A-C
143	Taper	Taper	0.563	1.000	0.563	LRFD-H1-1B-T
144	Taper	Taper	0.649	1.000	0.649	LRFD-H1-1B-C
145	Taper	Taper	0.499	1.000	0.499	LRFD-H1-1B-C
146	Taper	Taper	0.599	1.000	0.599	LRFD-H1-1B-C
147	Taper	Taper	0.441	1.000	0.441	LRFD-H1-1B-C
148	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-C
149	Taper	Taper	0.432	1.000	0.432	LRFD-H1-1B-C
150	Taper	Taper	0.669	1.000	0.669	LRFD-H1-1B-C
151	Taper	Taper	0.504	1.000	0.504	LRFD-H1-1B-C
152	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-C
153	Taper	Taper	0.660	1.000	0.660	LRFD-H1-1B-T

154	Taper	Taper	0.599	1.000	0.599	LRFD-H1-1B-C
155	Taper	Taper	0.473	1.000	0.473	LRFD-H1-1B-T
156	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
157	Taper	Taper	0.471	1.000	0.471	LRFD-H1-1B-T
158	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
159	Taper	Taper	0.471	1.000	0.471	LRFD-H1-1B-T
160	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
163	Taper	Taper	1.245	1.000	1.245	LRFD-H1-1A-C
165	Taper	Taper	1.249	1.000	1.249	LRFD-H1-1A-C
166	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
167	Taper	Taper	0.832	1.000	0.832	LRFD-H1-1B-T
168	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
169	Taper	Taper	0.821	1.000	0.821	LRFD-H1-1B-T
170	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
171	Taper	Taper	1.767	1.000	1.767	LRFD-H1-1B-T
172	Taper	Taper	0.938	1.000	0.938	LRFD-H1-1B-C
173	Taper	Taper	1.764	1.000	1.764	LRFD-H1-1B-T
174	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
175	Taper	Taper	1.032	1.000	1.032	LRFD-H1-1B-T
176	Taper	Taper	3.094	1.000	3.094	LRFD-H1-1A-C
177	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
178	Taper	Taper	3.098	1.000	3.098	LRFD-H1-1A-C
179	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
180	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
181	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
182	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
183	Taper	Taper	0.938	1.000	0.938	LRFD-H1-1B-C
184	Taper	Taper	0.609	1.000	0.609	LRFD-H1-1B-T
185	Taper	Taper	0.609	1.000	0.609	LRFD-H1-1B-T
186	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
187	Taper	Taper	0.611	1.000	0.611	LRFD-H1-1B-T
188	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
189	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
190	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
193	Taper	Taper	1.228	1.000	1.228	LRFD-H1-1A-C
195	Taper	Taper	1.220	1.000	1.220	LRFD-H1-1A-C
196	Taper	Taper	0.810	1.000	0.810	LRFD-H1-1B-C
198	Taper	Taper	0.784	1.000	0.784	LRFD-H1-1B-C
199	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
200	Taper	Taper	0.800	1.000	0.800	LRFD-H1-1B-T
202	Taper	Taper	0.774	1.000	0.774	LRFD-H1-1B-C
203	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
204	Taper	Taper	0.453	1.000	0.453	LRFD-H1-1B-C
205	Taper	Taper	0.600	1.000	0.600	LRFD-H1-1B-C
206	Taper	Taper	0.466	1.000	0.466	LRFD-H1-1B-T
207	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-C
208	Taper	Taper	0.467	1.000	0.467	LRFD-H1-1B-T
209	Taper	Taper	0.669	1.000	0.669	LRFD-H1-1B-C
210	Taper	Taper	0.438	1.000	0.438	LRFD-H1-1B-C
211	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-C
212	Taper	Taper	0.599	1.000	0.599	LRFD-H1-1B-C
213	Taper	Taper	2.092	1.000	2.092	LRFD-H1-1B-T
214	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
215	Taper	Taper	0.938	1.000	0.938	LRFD-H1-1B-C
216	Taper	Taper	1.826	1.000	1.826	LRFD-H1-1B-T
217	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
218	Taper	Taper	0.937	1.000	0.937	LRFD-H1-1B-C
219	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
220	Taper	Taper	3.148	1.000	3.148	LRFD-H1-1A-C
221	Taper	Taper	1.032	1.000	1.032	LRFD-H1-1B-T
222	Taper	Taper	3.116	1.000	3.116	LRFD-H1-1A-C

223	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
224	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
225	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
227	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
228	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
230	Taper	Taper	0.849	1.000	0.849	LRFD-H1-1B-C
231	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
232	Taper	Taper	0.869	1.000	0.869	LRFD-H1-1B-C
233	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
234	Taper	Taper	0.014	1.000	0.014	LRFD-H1-1B-C
235	Taper	Taper	1.845	1.000	1.845	LRFD-H1-1B-T
236	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
237	Taper	Taper	1.997	1.000	1.997	LRFD-H1-1B-T
238	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
239	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
240	Taper	Taper	0.854	1.000	0.854	LRFD-H1-1B-C
241	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
242	Taper	Taper	0.839	1.000	0.839	LRFD-H1-1B-C
243	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
244	Taper	Taper	0.335	1.000	0.335	LRFD-H1-1B-C
245	Taper	Taper	1.829	1.000	1.829	LRFD-H1-1B-T
246	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
247	Taper	Taper	1.880	1.000	1.880	LRFD-H1-1B-T
248	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
249	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
250	Taper	Taper	0.940	1.000	0.940	LRFD-H1-1B-C
251	Taper	Taper	0.940	1.000	0.940	LRFD-H1-1B-C
252	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
253	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
254	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
255	Taper	Taper	1.032	1.000	1.032	LRFD-H1-1B-T
256	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
257	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
258	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
259	Taper	Taper	0.659	1.000	0.659	LRFD-H1-1B-C
260	Taper	Taper	1.032	1.000	1.032	LRFD-H1-1B-T
261	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
266	Taper	Taper	3.652	1.000	3.652	LRFD-H1-1A-C
268	Taper	Taper	3.667	1.000	3.667	LRFD-H1-1A-C
270	Taper	Taper	3.585	1.000	3.585	LRFD-H1-1A-C
272	Taper	Taper	3.574	1.000	3.574	LRFD-H1-1A-C
273	Taper	Taper	0.941	1.000	0.941	LRFD-H1-1B-C
274	Taper	Taper	0.940	1.000	0.940	LRFD-H1-1B-C
275	Taper	Taper	0.600	1.000	0.600	LRFD-H1-1B-C
276	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-C
277	Taper	Taper	0.669	1.000	0.669	LRFD-H1-1B-C
278	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-C
279	Taper	Taper	0.599	1.000	0.599	LRFD-H1-1B-C
280	Taper	Taper	0.937	1.000	0.937	LRFD-H1-1B-C
281	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
282	Taper	Taper	0.941	1.000	0.941	LRFD-H1-1B-C
283	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
284	Taper	Taper	0.940	1.000	0.940	LRFD-H1-1B-C
285	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
286	Taper	Taper	0.938	1.000	0.938	LRFD-H1-1B-C
287	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
288	Taper	Taper	0.599	1.000	0.599	LRFD-H1-1B-C
289	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
290	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
291	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
292	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T

293	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
294	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
295	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
296	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
297	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
298	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-C
299	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
300	Taper	Taper	1.032	1.000	1.032	LRFD-H1-1B-T
301	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
302	Taper	Taper	1.032	1.000	1.032	LRFD-H1-1B-T
303	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
304	Taper	Taper	1.032	1.000	1.032	LRFD-H1-1B-T
305	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
306	Taper	Taper	1.032	1.000	1.032	LRFD-H1-1B-T
307	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
308	Taper	Taper	0.669	1.000	0.669	LRFD-H1-1B-C
309	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
310	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
311	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
312	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
313	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
314	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
315	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
316	Taper	Taper	1.029	1.000	1.029	LRFD-H1-1B-T
317	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
318	Taper	Taper	0.670	1.000	0.670	LRFD-H1-1B-C
319	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
320	Taper	Taper	0.938	1.000	0.938	LRFD-H1-1B-C
321	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
322	Taper	Taper	0.940	1.000	0.940	LRFD-H1-1B-C
323	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
324	Taper	Taper	0.940	1.000	0.940	LRFD-H1-1B-C
325	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
326	Taper	Taper	0.938	1.000	0.938	LRFD-H1-1B-C
327	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
328	Taper	Taper	0.599	1.000	0.599	LRFD-H1-1B-C
329	Taper	Taper	0.689	1.000	0.689	LRFD-H1-1B-C
330	Taper	Taper	0.697	1.000	0.697	LRFD-H1-1B-T
331	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
332	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
333	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
334	Taper	Taper	0.696	1.000	0.696	LRFD-H1-1B-T
335	Taper	Taper	0.443	1.000	0.443	LRFD-H1-1B-T
336	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
337	Taper	Taper	0.597	1.000	0.597	LRFD-H1-1B-T
339	Taper	Taper	0.697	1.000	0.697	LRFD-H1-1B-T
340	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
341	Taper	Taper	0.611	1.000	0.611	LRFD-H1-1B-T
342	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
343	Taper	Taper	0.634	1.000	0.634	LRFD-H1-1B-T
345	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
346	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
347	Taper	Taper	0.609	1.000	0.609	LRFD-H1-1B-T
348	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
349	Taper	Taper	0.634	1.000	0.634	LRFD-H1-1B-T
351	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T
352	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
353	Taper	Taper	0.609	1.000	0.609	LRFD-H1-1B-T
354	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
355	Taper	Taper	0.635	1.000	0.635	LRFD-H1-1B-T
357	Taper	Taper	0.778	1.000	0.778	LRFD-H1-1B-T

358	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
359	Taper	Taper	0.552	1.000	0.552	LRFD-H1-1B-T
360	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
361	Taper	Taper	0.597	1.000	0.597	LRFD-H1-1B-T
363	Taper	Taper	0.697	1.000	0.697	LRFD-H1-1B-T
364	Taper	Taper	0.829	1.000	0.829	LRFD-H1-1B-C
365	Rect	N/A				
366	Rect	N/A				
367	Rect	N/A				
368	Rect	N/A				
369	Rect	N/A				
370	Rect	N/A				
371	Rect	N/A				
372	Rect	N/A				
373	Rect	N/A				
374	Rect	N/A				
375	Rect	N/A				
376	Taper	Taper	0.076	1.000	0.076	LRFD-H1-1B-C
377	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
378	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
379	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-T
380	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-T
381	Taper	Taper	0.076	1.000	0.076	LRFD-H1-1B-T
385	Rect	N/A				
386	Rect	N/A				
387	Rect	N/A				
388	Rect	N/A				
389	Rect	N/A				
390	Rect	N/A				
391	Rect	N/A				
392	Rect	N/A				
393	Rect	N/A				
394	Rect	N/A				
395	Taper	Taper	0.597	1.000	0.597	LRFD-H1-1B-T
396	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
397	Taper	Taper	0.437	1.000	0.437	LRFD-H1-1B-T
398	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
399	Taper	Taper	0.473	1.000	0.473	LRFD-H1-1B-T
400	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
401	Taper	Taper	0.634	1.000	0.634	LRFD-H1-1B-T
402	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
403	Taper	Taper	0.472	1.000	0.472	LRFD-H1-1B-T
404	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
405	Taper	Taper	0.634	1.000	0.634	LRFD-H1-1B-T
406	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
407	Taper	Taper	0.472	1.000	0.472	LRFD-H1-1B-T
408	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
409	Taper	Taper	0.635	1.000	0.635	LRFD-H1-1B-T
410	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
411	Taper	Taper	0.437	1.000	0.437	LRFD-H1-1B-T
412	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
413	Taper	Taper	0.597	1.000	0.597	LRFD-H1-1B-T
414	Taper	Taper	0.148	1.000	0.148	LRFD-H1-1B-C
415	RD16	RD16	0.058	1.000	0.058	TENSION
416	RD16	RD16	0.301	1.000	0.301	TENSION
417	RD16	RD16	0.095	1.000	0.095	TENSION
418	RD16	RD16	0.237	1.000	0.237	TENSION
419	RD16	RD16	0.222	1.000	0.222	TENSION
420	RD16	RD16	0.039	1.000	0.039	TENSION
421	RD16	RD16	0.268	1.000	0.268	TENSION
422	RD16	RD16	0.037	1.000	0.037	TENSION

423	RD16	RD16	0.068	1.000	0.068	TENSION
424	RD16	RD16	0.243	1.000	0.243	TENSION
425	RD16	RD16	0.317	1.000	0.317	TENSION
426	RD16	RD16	0.086	1.000	0.086	TENSION
427	RD16	RD16	0.062	1.000	0.062	TENSION
428	RD16	RD16	0.240	1.000	0.240	TENSION
429	RD16	RD16	0.051	1.000	0.051	TENSION
430	RD16	RD16	0.267	1.000	0.267	TENSION
431	Taper	Taper	0.370	1.000	0.370	LRFD-H1-1B-C
432	Taper	Taper	0.419	1.000	0.419	LRFD-H1-1B-T
433	Taper	Taper	0.535	1.000	0.535	LRFD-H1-1B-T
434	Taper	Taper	0.527	1.000	0.527	LRFD-H1-1B-T
435	Taper	Taper	0.415	1.000	0.415	LRFD-H1-1B-T
436	Taper	Taper	0.371	1.000	0.371	LRFD-H1-1B-C
437	Taper	Taper	0.593	1.000	0.593	LRFD-H1-1B-T
438	Taper	Taper	0.546	1.000	0.546	LRFD-H1-1B-T
439	Taper	Taper	0.579	1.000	0.579	LRFD-H1-1B-T
440	Taper	Taper	0.352	1.000	0.352	LRFD-H1-1B-C
441	Taper	Taper	0.583	1.000	0.583	LRFD-H1-1B-T
442	Taper	Taper	0.348	1.000	0.348	LRFD-H1-1B-C
443	Taper	Taper	0.441	1.000	0.441	LRFD-H1-1B-T
444	Taper	Taper	0.603	1.000	0.603	LRFD-H1-1B-T
445	Taper	Taper	0.599	1.000	0.599	LRFD-H1-1B-T
446	Taper	Taper	0.510	1.000	0.510	LRFD-H1-1B-T
447	Taper	Taper	0.538	1.000	0.538	LRFD-H1-1B-T
448	Taper	Taper	0.564	1.000	0.564	LRFD-H1-1B-T
449	Taper	Taper	0.585	1.000	0.585	LRFD-H1-1B-T
450	Taper	Taper	0.567	1.000	0.567	LRFD-H1-1B-T
478	Taper	Taper	0.126	1.000	0.126	LRFD-H1-1B-T
480	Taper	Taper	0.196	1.000	0.196	LRFD-H1-1B-T
482	Taper	Taper	0.297	1.000	0.297	LRFD-H1-1B-T
484	Taper	Taper	0.097	1.000	0.097	LRFD-H1-1B-T
486	Taper	Taper	0.116	1.000	0.116	LRFD-H1-1B-T
488	Taper	Taper	0.231	1.000	0.231	LRFD-H1-1B-T
490	Taper	Taper	0.106	1.000	0.106	LRFD-H1-1B-T
492	Taper	Taper	0.674	1.000	0.674	LRFD-H1-1B-T
493	Taper	Taper	0.290	1.000	0.290	LRFD-H1-1B-T
494	Taper	Taper	0.667	1.000	0.667	LRFD-H1-1B-T
495	Taper	Taper	0.691	1.000	0.691	LRFD-H1-1B-T
496	Taper	Taper	0.612	1.000	0.612	LRFD-H1-1B-T
497	Taper	Taper	0.324	1.000	0.324	LRFD-H1-1B-T
498	Taper	Taper	0.671	1.000	0.671	LRFD-H1-1B-T
499	Taper	Taper	0.594	1.000	0.594	LRFD-H1-1B-T
500	Taper	Taper	0.301	1.000	0.301	LRFD-H1-1B-T
501	Taper	Taper	0.705	1.000	0.705	LRFD-H1-1B-T
502	Taper	Taper	0.644	1.000	0.644	LRFD-H1-1B-T
503	Taper	Taper	0.307	1.000	0.307	LRFD-H1-1B-T
504	Taper	Taper	0.680	1.000	0.680	LRFD-H1-1B-T
505	Taper	Taper	0.297	1.000	0.297	LRFD-H1-1B-T
506	Taper	Taper	0.723	1.000	0.723	LRFD-H1-1B-T
507	Taper	Taper	0.725	1.000	0.725	LRFD-H1-1B-T
508	Taper	Taper	0.642	1.000	0.642	LRFD-H1-1B-T
509	Taper	Taper	0.317	1.000	0.317	LRFD-H1-1B-T
510	Taper	Taper	0.284	1.000	0.284	LRFD-H1-1B-T
511	Taper	Taper	0.666	1.000	0.666	LRFD-H1-1B-T
512	Taper	Taper	0.683	1.000	0.683	LRFD-H1-1B-T
513	Taper	Taper	0.608	1.000	0.608	LRFD-H1-1B-T
514	Taper	Taper	0.088	1.000	0.088	LRFD-H1-1B-T
515	Taper	Taper	0.175	1.000	0.175	LRFD-H1-1B-T
516	CN6X057CS	N/A				
517	CN6X057CS	N/A				

518	CN6X057CS	N/A				
519	CN6X057CS	N/A				
520	CN6X057CS	N/A				
521	CN6X057CS	N/A				
522	CN6X057CS	N/A				
523	CN6X057CS	N/A				
524	CN6X057CS	N/A				
525	CN6X057CS	N/A				
526	CN6X057CS	N/A				
527	CN6X057CS	N/A				
528	CN6X057CS	N/A				
529	CN6X057CS	N/A				
530	CN6X057CS	N/A				
531	CN6X057CS	N/A				
532	CN6X057CS	N/A				
533	CN6X057CS	N/A				
534	CN6X057CS	N/A				
535	CN6X057CS	N/A				
536	CN6X057CS	N/A				
537	CN6X057CS	N/A				
538	CN6X057CS	N/A				
539	CN6X057CS	N/A				
540	CN6X057CS	N/A				
541	CN6X057CS	N/A				
542	CN6X057CS	N/A				
543	CN6X057CS	N/A				
544	CN6X057CS	N/A				
545	CN6X057CS	N/A				
546	CN6X057CS	N/A				
547	CN6X057CS	N/A				
548	CN6X057CS	N/A				
549	CN6X057CS	N/A				
550	Taper	Taper	0.710	1.000	0.710	LRFD-H1-1B-T
551	Taper	Taper	0.607	1.000	0.607	LRFD-H1-1B-T
552	CN6X057CS	N/A				
553	Taper	Taper	0.675	1.000	0.675	LRFD-H1-1B-T
554	Taper	Taper	0.321	1.000	0.321	LRFD-H1-1B-T
555	CN6X057CS	N/A				
556	CN6X057CS	N/A				
557	CN6X057CS	N/A				
558	Taper	Taper	0.666	1.000	0.666	LRFD-H1-1B-T
559	Taper	Taper	0.630	1.000	0.630	LRFD-H1-1B-C
560	Taper	Taper	0.250	1.000	0.250	LRFD-H1-1B-C
562	Taper	Taper	0.258	1.000	0.258	LRFD-H1-1B-T
563	Taper	Taper	0.183	1.000	0.183	LRFD-H1-1B-T
564	Taper	Taper	0.097	1.000	0.097	LRFD-H1-1B-T
565	Taper	Taper	0.630	1.000	0.630	LRFD-H1-1B-C
566	Taper	Taper	0.250	1.000	0.250	LRFD-H1-1B-C
569	Taper	Taper	0.680	1.000	0.680	LRFD-H1-1B-T
572	Taper	Taper	0.281	1.000	0.281	LRFD-H1-1B-T
573	Taper	Taper	0.108	1.000	0.108	LRFD-H1-1B-T
574	Taper	Taper	0.153	1.000	0.153	LRFD-H1-1B-T
575	Taper	Taper	0.201	1.000	0.201	LRFD-H1-1B-T
576	CN6X057CS	N/A				
581	CN6X057CS	N/A				
582	CN6X057CS	N/A				
584	CN6X057CS	N/A				
585	CN6X057CS	N/A				
586	CN6X057CS	N/A				
587	CN6X057CS	N/A				
588	CN6X057CS	N/A				

589	CN6X057CS	N/A				
590	CN6X057CS	N/A				
591	CN6X057CS	N/A				
592	CN6X057CS	N/A				
593	Taper	Taper	0.233	1.000	0.233	LRFD-H1-1B-T
596	Taper	Taper	0.100	1.000	0.100	LRFD-H1-1B-T
599	Taper	Taper	0.112	1.000	0.112	LRFD-H1-1B-T
600	CN6X057CS	N/A				
603	CN6X057CS	N/A				
604	CN6X057CS	N/A				
605	CN6X057CS	N/A				
608	CN6X057CS	N/A				
610	Taper	Taper	0.643	1.000	0.643	LRFD-H1-1B-T
611	Taper	Taper	0.608	1.000	0.608	LRFD-H1-1B-T
614	Taper	Taper	0.632	1.000	0.632	LRFD-H1-1B-T
615	Taper	Taper	0.204	1.000	0.204	LRFD-H1-1B-T
616	CN6X057CS	N/A				
617	Taper	Taper	0.634	1.000	0.634	LRFD-H1-1B-T
618	Taper	Taper	0.651	1.000	0.651	LRFD-H1-1B-T
619	Taper	Taper	0.729	1.000	0.729	LRFD-H1-1B-T
620	Taper	Taper	0.127	1.000	0.127	LRFD-H1-1B-T
621	Taper	Taper	0.749	1.000	0.749	LRFD-H1-1B-T
626	CN6X057CS	N/A				
627	CN6X057CS	N/A				
629	CN6X057CS	N/A				
630	CN6X057CS	N/A				
632	CN6X057CS	N/A				
633	CN6X057CS	N/A				
635	CN6X057CS	N/A				
639	CN6X057CS	N/A				
640	CN6X057CS	N/A				
641	CN6X057CS	N/A				
642	CN6X057CS	N/A				
643	CN6X057CS	N/A				
644	Taper	Taper	0.538	1.000	0.538	LRFD-H1-1B-T
645	Taper	Taper	0.676	1.000	0.676	LRFD-H1-1B-T
648	Taper	Taper	0.333	1.000	0.333	LRFD-H1-1B-T
650	Taper	Taper	0.697	1.000	0.697	LRFD-H1-1B-T
651	Taper	Taper	0.633	1.000	0.633	LRFD-H1-1B-T
652	Taper	Taper	0.558	1.000	0.558	LRFD-H1-1B-T
654	Taper	Taper	0.618	1.000	0.618	LRFD-H1-1B-T
655	Taper	Taper	0.537	1.000	0.537	LRFD-H1-1B-T
656	Taper	Taper	0.299	1.000	0.299	LRFD-H1-1B-T
657	Taper	Taper	0.158	1.000	0.158	LRFD-H1-1B-T
659	Taper	Taper	0.753	1.000	0.753	LRFD-H1-1B-T
660	CN6X057CS	N/A				
661	CN6X057CS	N/A				
662	CN6X057CS	N/A				
663	CN6X057CS	N/A				
664	CN6X057CS	N/A				
665	CN6X057CS	N/A				
666	CN6X057CS	N/A				
667	CN6X057CS	N/A				
668	CN6X057CS	N/A				
669	CN6X057CS	N/A				
671	CN6X057CS	N/A				
673	Taper	Taper	0.630	1.000	0.630	LRFD-H1-1B-T
674	Taper	Taper	0.631	1.000	0.631	LRFD-H1-1B-T
676	Taper	Taper	0.182	1.000	0.182	LRFD-H1-1B-T
677	Taper	Taper	0.205	1.000	0.205	LRFD-H1-1B-T
678	Taper	Taper	0.619	1.000	0.619	LRFD-H1-1B-C

679	CN6X057CS	N/A				
680	CN6X057CS	N/A				
681	CN6X057CS	N/A				
684	CN6X057CS	N/A				
685	CN6X057CS	N/A				
686	CN6X057CS	N/A				
688	Taper	Taper	0.253	1.000	0.253	LRFD-H1-1B-T
689	Taper	Taper	0.080	1.000	0.080	LRFD-H1-1B-T
691	CN6X057CS	N/A				
694	CN6X057CS	N/A				
696	CN6X057CS	N/A				
697	Taper	Taper	0.298	1.000	0.298	LRFD-H1-1B-T
698	Taper	Taper	0.298	1.000	0.298	LRFD-H1-1B-T
699	Taper	Taper	0.299	1.000	0.299	LRFD-H1-1B-T
700	Taper	Taper	0.298	1.000	0.298	LRFD-H1-1B-T
701	Taper	Taper	0.145	1.000	0.145	LRFD-H1-1B-T
702	Taper	Taper	0.558	1.000	0.558	LRFD-H1-1B-T
705	CN6X057CS	N/A				
711	CN6X057CS	N/A				
713	CN6X057CS	N/A				
715	Taper	Taper	0.617	1.000	0.617	LRFD-H1-1B-T
716	Taper	Taper	0.111	1.000	0.111	LRFD-H1-1B-T
717	CN6X057CS	N/A				
720	Taper	Taper	0.754	1.000	0.754	LRFD-H1-1B-T
721	Taper	Taper	0.155	1.000	0.155	LRFD-H1-1B-T
722	CN6X057CS	N/A				
723	CN6X057CS	N/A				
725	CN6X057CS	N/A				
730	Taper	Taper	0.647	1.000	0.647	LRFD-H1-1B-T
731	Taper	Taper	0.199	1.000	0.199	LRFD-H1-1B-T
790	PIP76X5.0	N/A				
807	PIP76X5.0	N/A				

Node Displacement Summary

	Node	**L/C**	**X** (in)	**Y** (in)	**Z** (in)	**Resultant** (in)	**rX** (rad)	**rY** (rad)	**rZ** (rad)
Max X	338	26:0.9D+1.3WL	**1.635**	-0.190	0.040	1.647	-0.000	-0.000	0.000
Min X	308	27:0.9D+1.3WL	**-1.867**	-0.183	-0.010	1.876	0.000	-0.000	-0.001
Max Y	9	27:0.9D+1.3WL	-1.498	**3.597**	0.007	3.896	0.002	-0.000	0.000
Min Y	44	10:LL R	0.000	**-1.499**	-0.001	1.499	0.000	-0.000	-0.000
Max Z	343	24:0.9D+1.5EQ	-0.003	-0.048	**35.863**	35.863	-0.001	0.001	-0.000
Min Z	296	20:1.2D+1.5EZ+	-0.077	-0.070	**-35.879**	35.879	0.002	-0.001	-0.000
Max rX	158	24:0.9D+1.5EQ	0.000	0.000	0.000	0.000	**0.196**	0.000	0.000
Min rX	157	20:1.2D+1.5EZ+	0.000	0.000	0.000	0.000	**-0.196**	0.000	0.000
Max rY	30	24:0.9D+1.5EQ	0.000	0.000	0.000	0.000	0.153	**0.014**	0.000
Min rY	30	25:0.9D+1.5EQ	0.000	0.000	0.000	0.000	-0.153	**-0.014**	0.000
Max rZ	391	27:0.9D+1.3WL	-1.318	1.732	0.015	2.176	0.001	0.000	**0.016**
Min rZ	305	27:0.9D+1.3WL	-1.647	2.043	0.003	2.624	0.001	-0.000	**-0.015**
Max Rst	311	20:1.2D+1.5EZ+ .5LF	-0.050	-0.415	-35.878	**35.881**	0.001	-0.000	0.002

Summary of Analysis:

According to the BNBC and AISC loads and design criteria, the Steel Structure of Echo Tex Printing building is structurally analyzed with the help of FEM software Staad.Pro, ed 15. According to the analysis following things can be summarized:

01. All the Secondary beams are passed.
02. Most of the Main beams are passed. Main beams of 1st floor between grid 2 to 4 and B to E show utilization ratio 1.03, which can be assumed as passed. But we will do further analysis in next step to make them under 1.0.
03. Some columns of ground floor are in critical condition. Some of the columns are in critical condition due to lack of lateral bracing in the system.
04. Lateral defection is too high which is close to 36 inch (maximum) which is unacceptable. Again this occurs due to improper lateral structural system.
05. Roof Rafters are passed.
06. Some top floor columns are in critical condition.

As some vertical members are in critical condition and lateral deflection is too high, so this structure is needed some retrofication which will be required to make the building safe both in vertical loads (Dead and Live Load) and lateral loads(Wind and Earthquake). Because of this requirement, the second analysis has been done to find out the requirements for retrofication.

STAAD.ProReport(Modified Condition)

Job Information

	Engineer	Checked	Approved
Name:			
Date:	31-Jan-16		

Structure Type SPACE FRAME

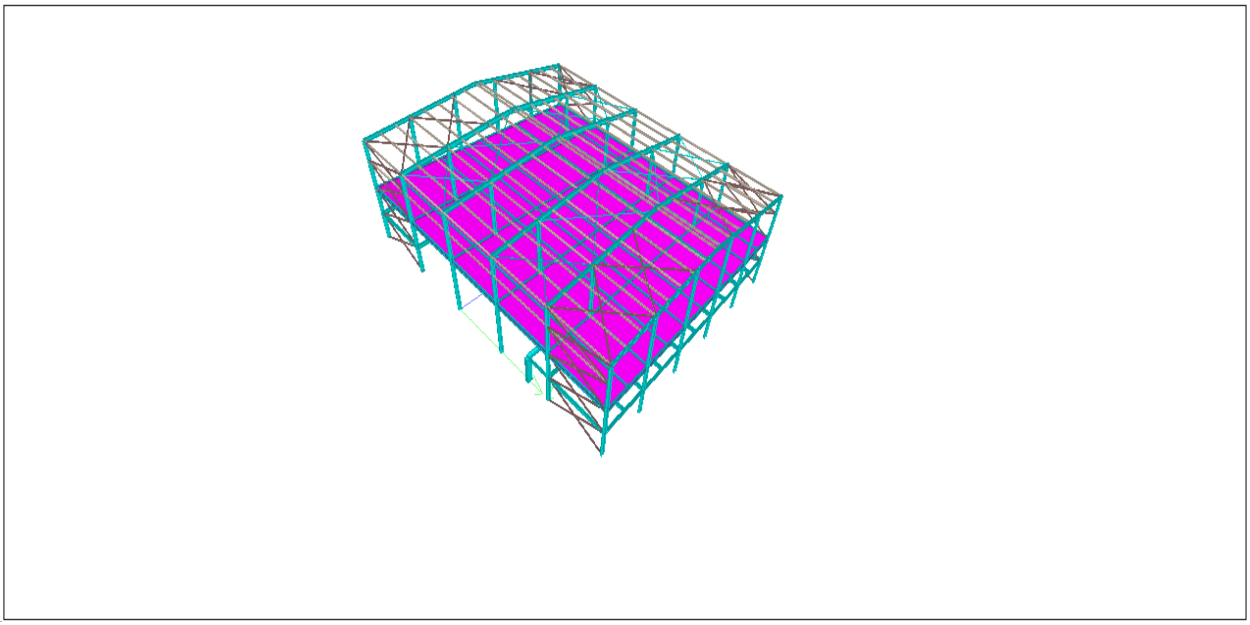
Number of Nodes	359	Highest Node	435
Number of Elements	671	Highest Beam	854
Number of Plates	25	Highest Plate	788

Number of Basic Load Cases	-2
Number of Combination Load Cases	18

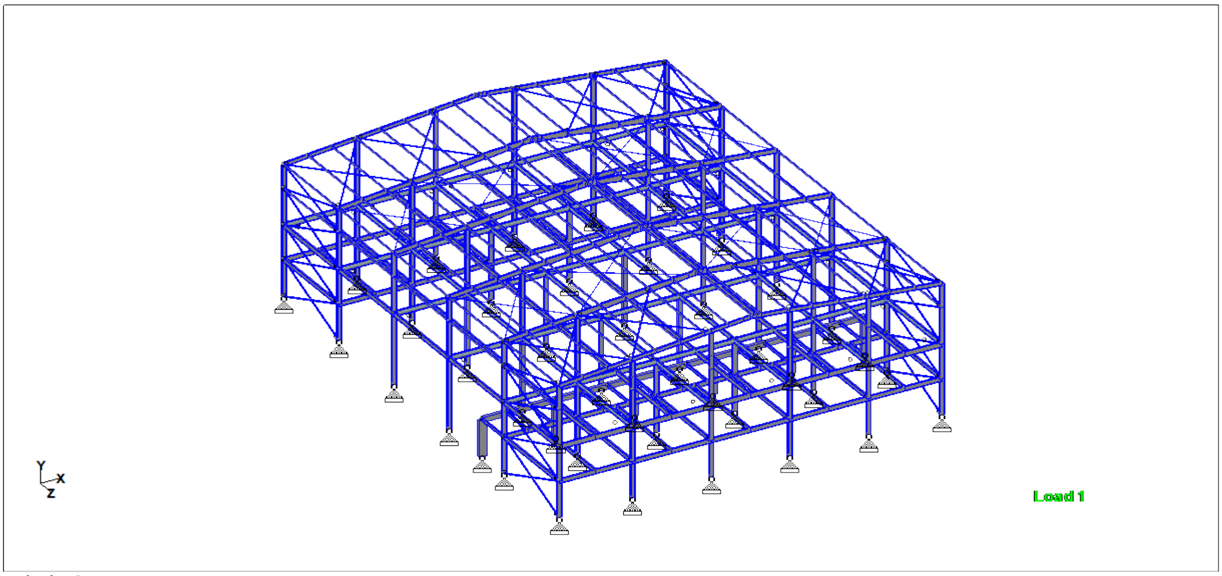
Included in this printout are data for:
All The Whole Structure

Included in this printout are results for load cases:

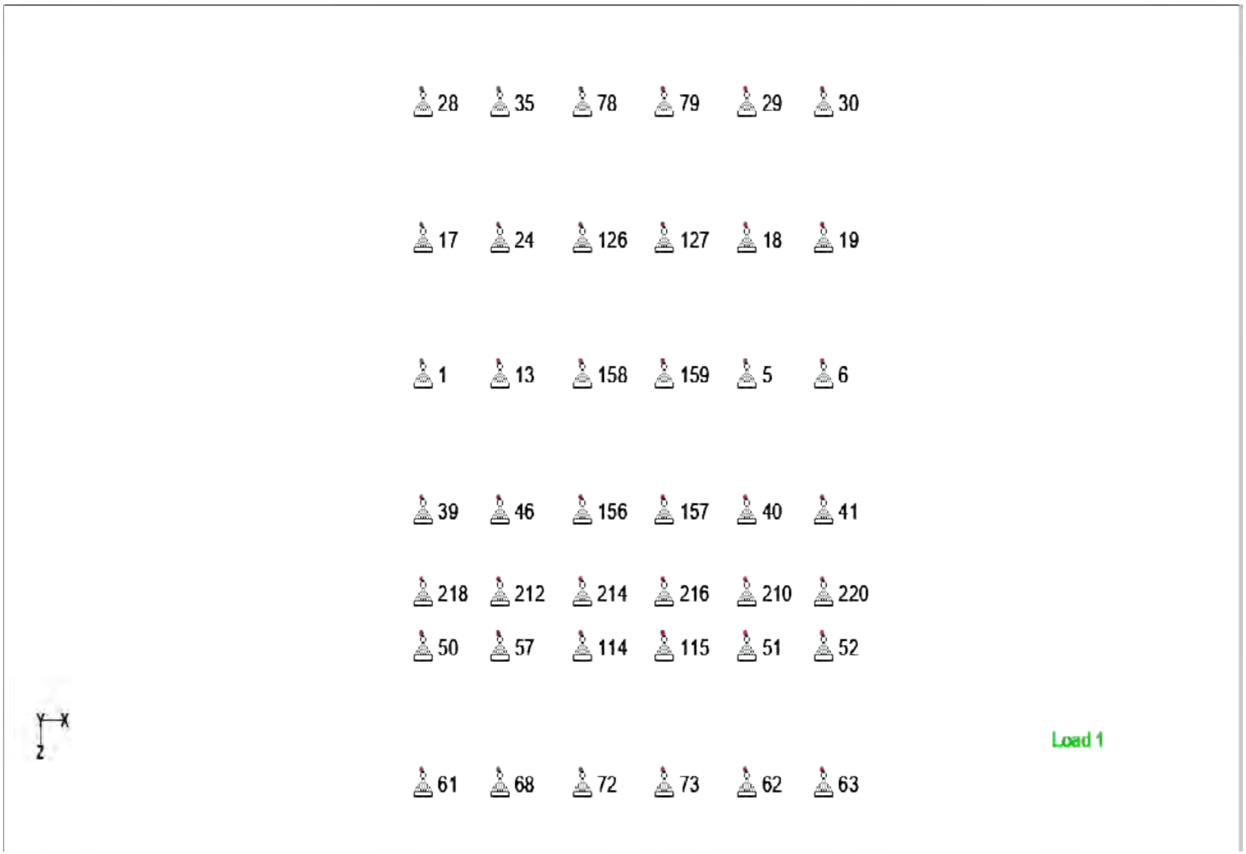
Type	L/C	Name
Primary	1	EQ X+
Primary	2	EQ X-
Primary	3	EQ Z+
Primary	4	EQ Z-
Primary	5	WL X+
Primary	6	WL X-
Primary	7	WL Z+
Primary	8	WL Z-
Primary	9	DL
Primary	10	LL R
Primary	11	LL F
Combination	12	1.4DL
Combination	13	1.2D+1.6LLF+0.5LLR
Combination	14	1.2D+1.3W X+0.5LF+0.5LR
Combination	15	1.2D+1.3W X- +0.5LF+0.5LR
Combination	16	1.2D+1.3W Z+0.5LF+0.5LR
Combination	17	1.2D+1.3W Z- +0.5LF+0.5LR
Combination	18	1.2D+1.5EX+.5LF
Combination	19	1.2D+1.5EX- +.5LF
Combination	20	1.2D+1.5EZ+.5LF
Combination	21	1.2D+1.5EZ- +.5LF
Combination	22	0.9D+1.5EQ X+
Combination	23	0.9D+1.5EQ X-
Combination	24	0.9D+1.5EQ Z+
Combination	25	0.9D+1.5EQ Z-
Combination	26	0.9D+1.3WL X+
Combination	27	0.9D+1.3WL X-
Combination	28	0.9D+1.3WL Z+
Combination	29	0.9D+1.3WL Z+



3D Rendered View



Whole Structure



Whole Structure

<u>Node Displacement Summary</u>

	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
Max X	330	26:0.9D+1.3WL X+	**1.554**	-0.175	-0.011	1.564	0.000	0.000	0.001
Min X	301	27:0.9D+1.3WL X-	**-1.800**	-0.163	-0.011	1.807	0.000	-0.000	-0.001
Max Y	9	27:0.9D+1.3WL X-	-1.438	**3.553**	-0.017	3.833	0.003	-0.000	0.000
Min Y	419	12:1.4DL	-0.251	**-2.662**	-0.026	2.674	-0.002	0.000	0.001
Max Z	258	16:1.2D+1.3W Z+0.5LF+0.5LR	-0.007	-0.051	**1.687**	1.687	0.008	-0.002	-0.000
Min Z	258	27:0.9D+1.3WL X-	-1.285	-0.028	**-1.456**	1.942	-0.007	0.001	0.002
Max rX	83	15:1.2D+1.3W X- +0.5LF+0.5LR	-1.455	-0.049	-0.204	1.470	**0.023**	0.002	0.001
Min rX	83	28:0.9D+1.3WL Z+	-0.000	-0.023	0.043	0.049	**-0.029**	-0.003	0.001
Max rY	388	27:0.9D+1.3WL X-	-1.445	0.032	0.106	1.449	0.010	**0.005**	0.001
Min rY	292	27:0.9D+1.3WL X-	-1.449	0.032	-0.107	1.453	-0.010	**-0.005**	0.001
Max rZ	391	27:0.9D+1.3WL X-	-1.261	1.719	-0.011	2.132	0.000	0.001	**0.015**
Min rZ	305	27:0.9D+1.3WL X-	-1.585	2.028	-0.022	2.573	0.000	-0.001	**-0.015**

Max Rst	9	27:0.9D+1.3WL X-	-1.438	3.553	-0.017	**3.833**	0.003	-0.000	0.000

Summary and conclusion:

For remolding the analysis following things are considered:

01. For lateral Stability Column and roof bracings (M.S. Pipe, 36 Grade) are considered between grid 1-2 and 5-6.
02. Stiffeners are provided in column and main beam to reduce the unbraced length of the members.
03. Ground floor columns between grids 3-4 and B-E has been modified to box section.

After analyzing with modified condition, the end result condition is pretty much satisfactory.It has found that:

01. All the structural members are passed according to code.
02. Lateral deflection is very satisfactory and reduced to 1.7 inch from 36 inch.

So It can be concluded that with these modification in existing steel structure of Eco Tex printing building, user can safely use the structure for existing printing activity purpose.

CHAPTER FIVE

RECOMMENDATION AND CONCLUSION

5.1 Recommendation

A structural engineer should always give utmost importance to the safety of the structure. In today's competitive world, it is often seen that for the greed of winning a contract, structural engineers are advised to reduce the weight of the building. It is a crime not to follow the codes and use unethical methods to compromise the safety of a structure. It is advised to follow the codes, rules and regulations strictly. In MSBPL, there is a good practice of not involving structural design engineers with marketing department and business development department so that they don't have any idea of a contract offer or tender. Their concentration is solely indebted to proper structural analysis and design.

5.2 Conclusion

Most of the structural engineers use ETABS or StaadPro for analysis and design purpose. Further knowledge of more detailed software is a must for later run. Moreover one should always have a clear concept of theoretical knowledge prior to operating software. Regular updates of codes and conduct should be kept in mind while designing. For this purpose, attending national and international seminars on Structural Engineering is required. Last but not the least , one should always renew his/her active membership for AISC (American Institute of Steel Construction).

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