Analysis of CFS Purlins and Girts Subjected to Cyclic Loading

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ABSTRACT

The design of metal building roof and wall systems is complicated because of thediversity of design variables, e.g., different purlin and girt cross-sections, simple or continuous span, through-fastened roof (wall) or standing seam roof, with or without insulation, and uplift (suction) or gravity (pressure) loadings. The overall objective of this project is to lay the groundwork for a new strength prediction approach that extends the American Iron and Steel Institute's North American Specifications, Direct Strength Method (DSM) to all types of metalbuilding wall and roof systems. The specific focus of this project presented herein is through-fastened simple span purlins or girts with the laterally unbraced free flange incompression caused by wind suction on a wall or cyclic load on a roof.

To calculate through-fastened purlin or girt system strength, a factor for including the rotation effect caused by shear flow and the rotational restraint is needed for DSM. Tian Gao conducted vaccum box test to validate DSM prediction method since the rotational restraint provided by the roof and wall sheathing plays an important role in the calculation of the flexural capacity of the through-fastened purlin and girt. Tian Gao research study not considered orientation of purlin section on the principal rafter which might cause changes in the buckling behaviour and buckling load capacity and also not conducted analytical study with the predicted rotational restraint. To account for the shear flow effect, and a rotational spring is applied in CUFSM version 4.0 to calculate thecritical buckling loads including the restraint from the sheathing. The same analytical study done in GBTUL version 2.0 software. In total 49 specimens including mainly Zed sections and Channel sections having different cross section dimension, thickness, yield stress chosen from research study conducted by Tian Gao.

Buckling behaviour with considering rotational restraint in analytical study done with CUFSM version 4.0 and GBTUL version 2.0 are studied and load capacity calculated. Comparisons made between CUFSM and GBTUL analytical results and between load capacity from DSM approach in AISI S100-2007 North American Code and Experimental load capacity given by Tian Gao in his research work.

Keywords : - GBTUL,C Section,Z Section,Purlin,Girts.

1. INTRODUCTION

Customarily,the roof top and mass of the building will be work with the assistance of the areas which are made from the pregalvanised steel strip as curls i.e.light gaged steel. The areas may be C, Z, sigma ,uneven sigma ,or cap segment. We individuals are familiar about fixins of rooftop and divider, the rooftop units are known as optional basic steel part implies purlin and divider unit known to be girts which gives horizontal support to the divider board to oppose wind stack. Purlins and girts having a similar sectional property. From fig. 1.1 it will be obvious that for the most part girt are not lapped but rather to give more proficiency and coherence the purlins expected to be lapped.

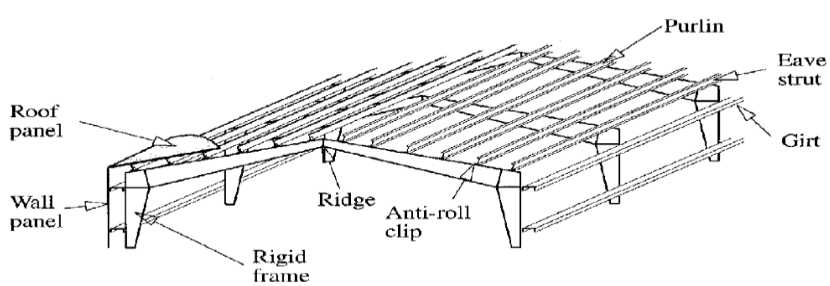

Fig.1 Roof Top of Building

1.2 NEED FOR THE STUDY

To break down structure for cyclic load utilizing STADD PRO AND ANSYS to rsume relentless work,.TianGao inquire about review not considered introduction of purlin on the chief beam which may bring about changes in the clasping conduct and there by change in clasping limit furthermore not directed investigative review with the anticipated rotational restriction.

2. OBJECTIVES OF THE STUDY

- Specimens will be analyzed using Finite element software for Behavioral study under influence of combine bending, shear and rotational restraint on capacity of cold formed steel purlins and girts and influence of roof angle.
- Analyze by taking cyclic loads.
- To account for the shear flow effect, and a rotational spring is applied in CUFSM version 4.0 to calculate the critical buckling loads including the restraint from the sheathing.
- The same analytical study done in GBTUL version 2.0 software.
- In total 49 specimens including mainly Zed sections and Channel sections having different cross section dimension, thickness, yield stress chosen from research study conducted by TianGao.
- Buckling behaviour with considering rotational restraint in analytical study done with CUFSM version 4.0 and GBTUL version 2.0 are studied and load capacity calculated.
- Comparisons to be made between CUFSM and GBTUL analytical results and between load capacity from DSM approach in AISI S100-2007 North American Code and Experimental load capacity given by TianGao in his research work.

3. METHODOLOGY

An extensive analytical study carried out in Finite Strip Method (FSM) and Generalized Beam Theory (GBT) based software packages which includes CUFSM version 4.0 and GBTUL version 2.0. Rotational restraint was considered by introducing rotational spring constant derived from TianGao research work. Both CUFSM and GBTUL software has same template of analysis but with different procedure and shape functions whereas CUFSM considered modal decomposition in addition to member analysis and GBTUL considered cross section analysis in addition to member analysis. Specimen centre line dimension at various rotation angle calculated using Creo Parametric version 2.0 software.

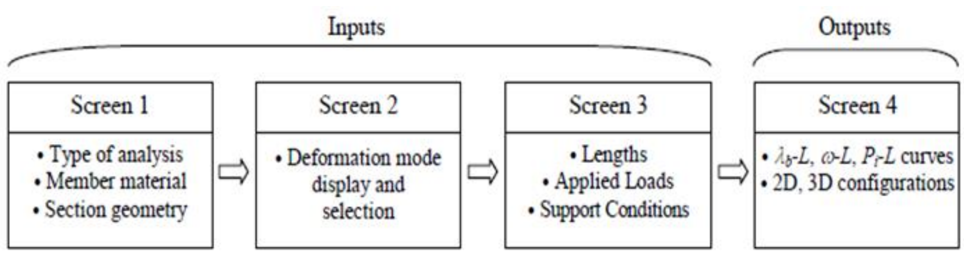

Fig 2 GBTUL – Structure of the Graphic Interface

Using Finite Strip Method based software CUFSM and Generalized Beam Theory based software GBTUL parametric study done for 49specimen chosen from Prof. TianGao Research work and found reference stress directly in case of GBTUL output and from Load factor in case of CUFSM output. With help of initial work done by Prof. TianGao evaluated that CUFSM output shows consistent result. Hence Design Strength of sections including purlins and girts calculated using Direct Strength Method (DSM) aided by AISI S100-2007 North American Code.

Table 3.1 DSM Capacity of Specimens

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Sl. No	Specimen	Exp. Buckling Moment, KNm	DSM Buckling Moment, KNm				
			0 deg.	10 deg.	15 deg.	20 deg.	25 deg.
1	Z200D-2	11.90	11.79	7.68	6.59	5.96	5.68
2	Z200D-3	11.50	2.25	6.21	4.92	4.17	3.13
3	Z200B-1	13.10	9.69	5.08	4.63	3.77	2.68
4	Z200B-2W	13.50	10.95	6.45	5.97	5.26	4.28
5	Z250D-1	7.10	11.36	16.11	17.79	17.69	17.62
6	Z250D-2	7.00	11.28	15.90	17.58	17.86	17.88
7	Z250B-1	6.80	11.19	17.50	17.18	17.45	17.81
8	Z250B-2	7.30	11.01	15.57	15.60	17.33	17.09
9	C200D-1	12.10	19.38	13.46	12.77	11.85	10.49
10	C200D-2	10.60	19.83	13.92	12.63	11.62	11.03
11	C250D-1	5.20	2.98	10.49	12.60	12.55	14.20
12	C250D-2	5.20	2.91	8.19	10.55	12.26	13.98
13	Z200D-R100-1	12.20	10.07	5.38	4.95	2.42	2.22
14	Z200D-R100-2	7.40	10.48	5.92	5.44	4.64	4.40
15	Z200D-TH25-1	11.70	10.14	5.90	4.56	3.78	3.54
16	Z200D-TH25-2	12.40	10.41	6.62	5.38	4.66	3.66
17	Z200D-TH50-1	12.80	10.12	6.29	5.72	5.06	3.96
18	Z200D-TH50-2	12.20	10.48	5.81	5.21	4.43	3.26
19	Z200D-TH100-1	11.00	10.00	6.29	5.07	5.36	3.26
20	Z200D-TH100-2	14.50	10.95	7.09	6.63	5.86	5.04
21	Z200B-TH25-1	13.10	10.46	5.95	5.47	4.67	3.66
22	Z200B-TH25-2	10.00	10.53	6.59	5.32	4.59	3.58
23	Z200B-TH50-1	15.10	10.07	6.38	5.16	4.40	4.06
24	Z200B-TH50-2	13.80	10.78	5.78	6.02	4.45	3.33
25	Z200B-TH100-1	12.90	10.46	5.75	5.26	4.52	3.42
26	Z250D-TH25-1	7.20	11.31	17.49	17.48	17.73	17.47
27	Z250D-TH25-2	7.10	11.48	6.62	17.30	17.54	17.50
28	Z250D-TH50-1	6.60	15.30	16.30	16.36	17.99	17.89
29	Z250D-TH50-2	7.10	11.45	16.12	16.17	17.99	17.72
30	Z250D-TH100-1	8.50	11.27	17.47	17.61	17.83	17.75
31	Z250D-TH100-2	6.60	11.42	17.42	17.53	17.83	17.68
32	Z250B-TH25-1	6.40	11.21	17.23	17.20	17.43	18.02
33	Z250B-TH25-2	8.00	11.35	17.49	17.46	17.72	17.64
34	Z250B-TH50-1	8.50	11.32	15.60	17.31	17.60	17.63
35	Z250B-TH50-2	8.00	11.40	17.36	17.40	17.68	17.70
36	Z250B-TH100-1	7.80	9.52	15.26	15.39	15.69	17.07
37	Z250B-TH100-2	8.20	11.52	17.88	17.85	17.92	17.90
38	C200D-TH25-1	7.30	19.36	13.56	12.17	11.21	9.96
39	C200D-TH25-2	8.00	19.86	13.72	12.40	11.36	10.04
40	C200D-TH50-1	8.70	18.81	13.37	11.96	11.02	9.58
41	C200D-TH50-2	10.00	19.09	13.38	11.96	10.97	9.61
42	C200D-TH100-1	12.40	19.83	13.13	11.59	10.52	9.06
43	C200D-TH100-2	8.30	18.91	12.90	11.31	10.22	9.58
44	C250D-TH25-1	4.60	4.02	7.61	10.11	11.95	12.14
45	C250D-TH25-2	5.90	2.85	7.57	9.96	11.82	12.16
46	C250D-TH50-1	4.80	4.00	7.78	10.19	10.67	10.97
47	C250D-TH50-2	3.50	4.04	8.02	10.56	10.81	12.51
48	C250D-TH100-1	5.10	2.90	7.71	10.15	12.02	13.70
49	C250D-TH100-2	6.50	2.89	9.79	11.98	12.00	13.72

4. CYCLIC LOAD TEST RESULT

PARAMETERS OF COLD-FORM STEEL INDUSTRIAL BUILDING

Basic wind speed=50m/s

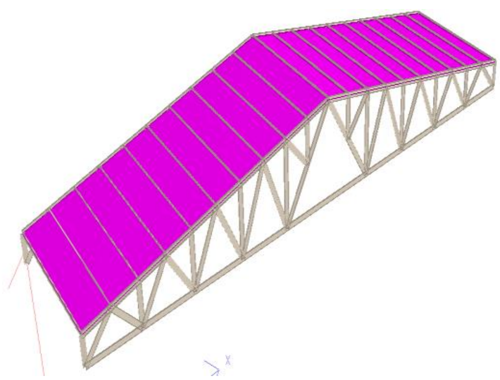
Building width= 25m

Building Length: 120m

Height of building (upto eves) =9m

Class of building = A

industrial building of size = 25mX120m



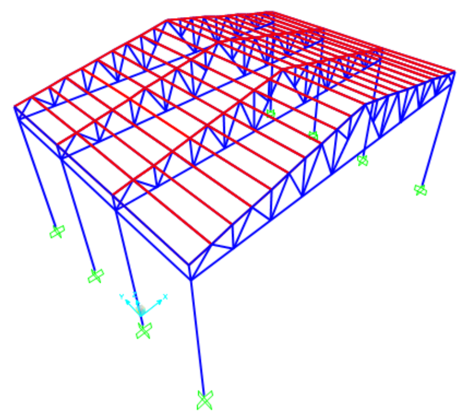


Fig. 3 Stadd Model **Fig.** **4**Truss With Purlins

Application of sine waves in SAP 2000 as a wind time history then I got hysteresis loop

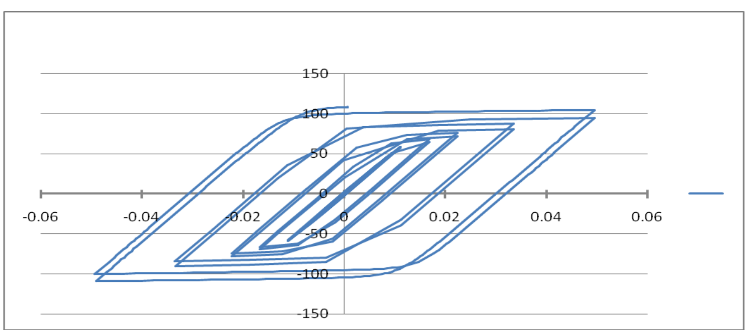


Fig. 5. Hystrisis graph

5. CONCLUSIONS

Rotational restraint must be considered to estimate nominal moment capacity of section. And orientation of purlins also played vital role in load capacity of purlins especially and should be considered for arriving realistic design capacity. Software investigation involving a large number of cyclic test has been conducted on purlins and girts of C and Z section of cold formed steel. The results have been used to quantify the effects of cyclic wind uplift on cold formed steel purlins and girts.

6. REFERENCES

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