To: All
Authorized Persons
Registered Structural Engineers
Registered Geotechnical Engineers
Registered Inspectors
Registered General Building Contractors
Registered Specialist Contractors
Registered Minor Works Contractors

21 November 2016

Dear Sir/Madam,

Amendments to Code of Practice for the Structural Use of Steel 2011

Subsequent to the publication of the Code of Practice for the Structural Use of Steel 2011 (the Code), the Technical Committee (TC) set up by this department regularly collects views and feedbacks received from the practitioners and the stakeholders arising from the use of the Code, and reviews the contents thereof for the necessary update.

2. The TC has recommended certain amendments to the Code with a view to supplementing some updated technical information on structural use of steel and clarifying the ambiguities and/or irregularities identified therein.

3. The said amendments are promulgated with immediate effect and they have been uploaded to the website of the Buildings Department (BD) at www.bd.gov.hk. The major amendments include:-

(i) updating the characteristic strength of reinforcement bar from 460 N/mm$^2$ to 500 N/mm$^2$ in accordance with the latest reinforcement bar standard CS2:2012 and the parameters of characteristic resistance of headed shear stud in different grades of concrete shown in Table 10.7;

(ii) including an additional Table 12.2e on strength reduction factors for hot rolled reinforcing bars at elevated temperatures and Chinese standard GB/T 700-2006 in the Acceptable Standard List in Annex A1.1.3;

(iii) explicating the need on second-order direct analysis for members in bending and sensitive to buckling in Equation 6.14 and the term of restrained beam mentioned in Clause 8.2 for consideration of lateral torsional buckling;

(iv) standardizing the two similar terms of “oscillation” and “vibration” to the latter to remove ambiguity and tally with that in the Chinese version; and

...(v)....
(v) correcting the typo errors on expression of the reduction factor in Equation 9.23 and designation of buckling curves for S460 hot-finished structural hollow section in Table 8.7.

Yours sincerely,

YC LEE
Assistant Director / New Buildings 2 for Building Authority
## Amendments to the Code of Practice for Structural Use of Steel 2011

<table>
<thead>
<tr>
<th>Item</th>
<th>Clause/Annex</th>
<th>Current Version</th>
<th>Amendments</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clause 1.1 – para. 9</td>
<td>Section 5 contains particular requirements and guidance for deflection control and structural dynamics including serviceability criteria for wind induced oscillation of tall buildings. The section also covers durability and protection against corrosion attack.</td>
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<td>Clause 1.2.5 – para. 3</td>
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<td>Situations where fatigue resistance needs to be considered include the following:  - Where there are wind-induced oscillations due to aerodynamic instability. Normal fluctuations in wind loading need not be considered.  - Structural members that support heavy vibratory plant or machinery.  - Members that support cranes as defined in clause 13.7.  - Bridge structures, which will normally be designed to a bridge design code.</td>
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</table>

Legends: revision/addition
6 Clause 5.2
- Table 5.1

WIND-INDUCED OSCILLATION
Vibration and oscillation of a structure should be limited to avoid discomfort to users and damage to contents. For special structures, including long-span bridges, large stadium roofs, chimneys, wind tunnel model tests are recommended for their wind resistant design to meet serviceability limits.

The terms “oscillation” and “vibration” are collectively read as “vibration” for consistency hence the word “oscillation” is deleted.

7 Clause 5.3

WIND-INDUCED VIBRATION
Vibration of a structure should be limited to avoid discomfort to users and damage to contents. For special structures, including long-span bridges, large stadium roofs and chimneys, wind tunnel model tests are recommended for their wind resistant design to meet serviceability limits.

The terms “oscillation” and “vibration” are collectively read as “vibration” for consistency.

8 Clause 5.3.2

Serviceability limit state
The serviceability limit states on oscillation, deflection and acceleration should be checked to ensure serviceable condition for the structure.

Natural frequencies
Structural analysis programmes should be used to determine the natural frequencies of vibration of buildings and structures to mitigate excessive horizontal oscillation and vertical vibration. Empirical formulae can also be used for approximated vibration analysis of typical and regular buildings.

The terms “oscillation” and “vibration” are collectively read as “vibration” for consistency hence the word “oscillation” is deleted.

9 Clause 5.3.3.1

Serviceability criteria for communication and broadcasting towers
Communication and broadcasting services demand minimal disruption to transmission. The serviceability limits for communication and broadcasting towers are selected to meet the performance specifications of antennas and other transmission devices to be mounted on those towers. Excessive oscillation and vibration of towers should be avoided. For design, reference should be made to specialist literature.

The terms “oscillation” and “vibration” are collectively read as “vibration” for consistency hence the word “oscillation” is deleted.

10 Clause 5.3.5

Communication and broadcasting services demand minimal disruption to transmission. The serviceability limits for communication and broadcasting towers are selected to meet the performance specifications of antennas and other transmission devices to be mounted on those towers. Excessive oscillation and vibration of towers should be avoided. For design, reference should be made to specialist literature.

For second-order direct analysis, imperfections in both axes should be considered for members in bending about strong axis and sensitive to lateral torsional buckling.

11 Clause 6.8.3 – equation 6.14

Member lateral-torsional and torsional buckling checks are carried out separately or alternatively by replacing $M_{ad}$ in the above equation by the buckling resistance moment $M_b$ in Equations 6.20 to 6.22. If moment equivalent factor $m_{v}$ is less than 1, both Equation 6.12 or 6.13 and Equation 6.14 are required for member resistance check.

$F_{v} = \frac{M_{ad}}{M_{b}} = \frac{M_{ad}}{M_{b}} = \frac{m_{v} \left[ M_{b} + F_{v} \left( L_{x} + d_{y} \right) \right]}{M_{b}} = \frac{m_{v} \left[ M_{b} + F_{v} \left( L_{x} + d_{y} \right) \right]}{M_{b}}$ (6.14)

The equivalent uniform moment factor $m_{v}$ for beams and the moment equivalent factor $m_{v}$ for flexural buckling can be referred to Tables 8.4 a & b and Table 8.9.

For members in bending and sensitive to buckling, imperfection on both axes should be considered if effective length has reduction in capacity about buckling in both axes.
### 8.2 - para.1

**REstrained Beams**

Restrained beams refer to beams provided with full lateral restraint to their top flanges and with full torsional restraint at their ends. In such a case, lateral-torsional buckling should not occur before plastic moment capacity.

#### Notes:
- Revisions/additions.

### 8.7.6 - Table 8.7

**Typo error on designation of buckling curves for the grade of hot-finished structural hollow section less than or equal to S460 is rectified.**

**Table 8.7 - Designation of buckling curves for different section types**

<table>
<thead>
<tr>
<th>Type of section</th>
<th>Maximum thickness (see note1)</th>
<th>Axis of buckling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot-finished structural hollow sections with steel grade &gt; S460 or hot-finished seamless structural hollow sections</td>
<td>Any axis</td>
<td>(a)</td>
</tr>
<tr>
<td>Hot-finished structural hollow section &lt; grade S460</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Cold-formed structural hollow section or longitudinal seam weld or spiral weld</td>
<td>Any axis</td>
<td>(a)</td>
</tr>
<tr>
<td>Rolled I-section</td>
<td>≤ 40 mm</td>
<td>(a)</td>
</tr>
<tr>
<td>Rolled H-section</td>
<td>≤ 40 mm</td>
<td>(a)</td>
</tr>
<tr>
<td>Welded I- or H-section (see note 2)</td>
<td>≤ 40 mm</td>
<td>(a)</td>
</tr>
<tr>
<td>Rolled I-section with welded flange cover plates</td>
<td>≤ 40 mm</td>
<td>(a)</td>
</tr>
<tr>
<td>Rolled H-section with welded flange cover plates</td>
<td>≤ 40 mm</td>
<td>(a)</td>
</tr>
<tr>
<td>Rolled I-section with welded flange cover plates with UB ≤ 0.80 as shown in Figure 8.4</td>
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<td>(a)</td>
</tr>
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<td>(a)</td>
</tr>
<tr>
<td>Welded box section (see note 3)</td>
<td>≤ 40 mm</td>
<td>(a)</td>
</tr>
<tr>
<td>Rolled angle, channel or T-section</td>
<td>Any axis</td>
<td>(a)</td>
</tr>
<tr>
<td>Two rolled sections laced, bolted or back-to-back</td>
<td>Any axis</td>
<td>(a)</td>
</tr>
<tr>
<td>Compound rolled sections</td>
<td>Any axis</td>
<td>(a)</td>
</tr>
</tbody>
</table>

#### Notes:
1. For thicknesses between 40mm and 50mm the value of $a$ may be taken as the average of the values for thicknesses up to 40mm and over 50mm for the relevant value of $t_o$.
2. For welds or in sections with their flanges thermally cut by machine without subsequent edge grinding or machining, for buckling about the y-y axis, curve (c) may be used for flanges up to 40mm thick and 150mm wide.
3. The category “welded box section” includes any box section fabricated from plates or rolled sections, provided that all of the longitudinal welds are near the corners of the cross-section.
4. Use of buckling curves based on other recognised design codes allowing for variation between load and material factors and calculated against Tables 8.9a-c, (a) to (c) is acceptable. See also footnote under Table 8.10.

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<td>(a)</td>
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<td>(a)</td>
</tr>
<tr>
<td>Welded box section (see note 3)</td>
<td>≤ 40 mm</td>
<td>(a)</td>
</tr>
<tr>
<td>Round, square or flat bar</td>
<td>≤ 40 mm</td>
<td>(a)</td>
</tr>
<tr>
<td>Rolled angle, channel or T-section</td>
<td>Any axis</td>
<td>(a)</td>
</tr>
<tr>
<td>Two rolled sections laced, bolted or back-to-back</td>
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4. Use of buckling curves based on other recognised design codes allowing for variation between load and material factors and calculated against Tables 8.9a-c, (a) to (c) is acceptable. See also footnote under Table 8.10.
**Clause 9.3.6.1.6 - equation 9.23**

Bolts through packing
When a bolt passes through packing with thickness $t_p$ greater than one-third of the nominal diameter $d$, its shear capacity $P_s$ should be reduced by multiplying a reduction factor $\beta_p$ obtained from:

$$\beta_p = \frac{d}{d - 3t_p} \leq 10$$  \hspace{1cm} (9.23)

For double shear connections with packing on both sides of connecting member, $t_p$ should have the same thickness; otherwise, the thicker $t_p$ should be used.

This provision does not apply to preloaded bolt (friction-type) connections when working in friction, but does apply when such bolts are designed to slip into bearing.

**Clause 10.1.3**

Reinforcement
Reinforcement shall comply with HRCC, and the characteristic strength $f_y$ shall not be larger than 460 N/mm$^2$. The elastic modulus shall be taken as 205 kN/mm$^2$, i.e. same as that of structural steel sections.

Different types of reinforcement may be used in the same structural member.

**Clause 10.3.2.2 - Table 10.7**

(a) The column “Nominal height” is deleted.
(b) The minimum as-welded height of 25mm shank diameter shear stud is amended.
(c) The corresponding characteristic resistances of headed shear stud for various concrete cube strengths are revised.
**Clause 12.1**

**DESIGN PRINCIPLES**

This section aims to provide guidance on fire resistant design in steel and composite structures which deals primarily with minimizing the risk of structural collapse and restricting the spread of fire through the structure.

The fire resistant design method is applicable to steel and composite structures with the following materials:

- **Structural steel:** Hot rolled steel sections with design strengths equal to or less than 480 N/mm².
- **Cold formed steel sections with design strengths equal to or less than 550 N/mm²**.
- **Concrete:** Normal weight concrete with cube strengths equal to or less than 60 N/mm².
- **Reinforcement:** Cold worked reinforcing bars with design strengths equal to or less than 480 N/mm².

For steel materials other than those listed above, refer to specialist design recommendations. Alternatively, passive fire protection method should be adopted.

The design strength of reinforcement bar is changed to 500N/mm² to meet the latest reinforcement bar standard CS2:2012.

**Clause 12.1.4 - Table 12.2c (added)**

A table extracted from BS EN 1992-1-2:2004 showing the strength reduction factors for hot rolled bars at elevated temperatures is added.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Strength reduction factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°C</td>
<td>1.00</td>
</tr>
<tr>
<td>100°C</td>
<td>1.00</td>
</tr>
<tr>
<td>200°C</td>
<td>1.00</td>
</tr>
<tr>
<td>300°C</td>
<td>1.00</td>
</tr>
<tr>
<td>400°C</td>
<td>1.00</td>
</tr>
<tr>
<td>500°C</td>
<td>0.78</td>
</tr>
<tr>
<td>600°C</td>
<td>0.47</td>
</tr>
<tr>
<td>700°C</td>
<td>0.23</td>
</tr>
<tr>
<td>800°C</td>
<td>0.11</td>
</tr>
<tr>
<td>900°C</td>
<td>0.06</td>
</tr>
<tr>
<td>1000°C</td>
<td>0.04</td>
</tr>
<tr>
<td>1100°C</td>
<td>0.02</td>
</tr>
<tr>
<td>1200°C</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Clause 13.2.5**

**Serviceability issues**

The following serviceability issues shall be addressed for towers and masts:

(a) Wind induced oscillations of antennas, structural elements and cables.
(b) Access for maintenance of steelwork can be very difficult, therefore a high quality protective system should be specified.
(c) Required stiffness for purpose (e.g. microwave alignment).
(d) Access facilities for routine maintenance and inspection shall be designed to take into account of the availability and likely competence of staff trained to climb such structures but should normally include ladders fitted with a fall arrest system and regular platforms to rest and safely place work equipment.

The terms “oscillation” and “vibration” are collectively read as “vibration” for consistency.
### Design issues for steel chimneys

In addition to the guidance given in clauses 13.2.1 to 13.2.5, special attention should be given to the following in the design of steel chimneys and flues:

**(a)** Wind-excited oscillations should be considered and analyzed by aerodynamic methods. For circular chimneys the simplified method in clause 13.2.8 may be used.

**(b)** Design should be in accordance with the appropriate provisions of the Code and in the acceptable references in Annex A2.1.

**(c)** To control buckling in the case of a thin-walled chimney with effective height to diameter ratio of less than 21 and diameter to thickness ratio of less than 130, the ultimate compressive stresses in the chimney structure arising from the three principal load combinations shall be limited to a value calculated in accordance with Table 12.2 of clause 12.1.4 which allows for reduced steel strength at elevated temperatures. If this value exceeds 140 N/mm², then a value of 140 N/mm² shall be used. The value should be reduced further for higher aspect ratios.

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### Wind-excited oscillations of circular chimneys

Flexible slender structures are subject to oscillations caused by cross wind and along wind action. Structures with a circular cross section, such as chimneys, oscillate more strongly across than along wind.

The following simplified approach may be used for across wind oscillation, see also clause 5.3:

**(a)** The Strouhal critical velocity \( V_{crit} \) in metres per second for the chimney is to be determined by:

\[
V_{crit} = 5 \frac{D_i}{f}
\]

where \( f \) (in Hz) is the natural frequency of the chimney on its foundations. This may be calculated analytically or from the following approximate formula for the case of a regular cone:

\[
f = \frac{5000D_i - D_b}{h}
\]

and

- \( h \) is the height of chimney (in m)
- \( D_i \) is the diameter at top (in m)
- \( D_b \) is the diameter at bottom (in m)
- \( W \) is the mass per metre height at top of structural shell including lining or encasing, if any (in kg)
- \( W_s \) is the mass per meter height of top of structural shell excluding lining (in kg)

**(b)** If \( V_{crit} \) exceeds the design wind velocity in metres per second given by the following formula:

\[
V = 40 \sqrt{g}
\]

where \( g \) is the design wind pressure in kN/m², severe oscillation is unlikely and no further calculation is required.

**(c)** If \( V_{crit} \) is less than the design wind velocity, the tendency to oscillate \( C \) may be estimated by the following empirical formula:

\[
C = 0.6 + K \left( \frac{10D_i^2}{W} - 1.5 \frac{\Delta}{D_i} \right)
\]

where

- \( \Delta \) is the calculated deflection (in m) at the top of the chimney for unit distributed load of 1 kPa
- \( K \) is 3.0 for all welded construction, 3.0 for welded with flanged and bolted joints and 2.5 for bolted and riveted or all riveted.

**(d)** If \( C \) is less than 1.0, severe oscillation is unlikely. If \( C \) is between 1.0 and 1.3 the design wind pressure for the chimney should be increased by a factor \( C^* \). If \( C \) is larger than 1.3 stabilizers or dampers should be provided to control the oscillations.

### Wind-excited vibrations of circular chimneys

Flexible slender structures are subject to vibrations caused by cross wind and along wind action. Structures with a circular cross section, such as chimneys, oscillate more strongly across than along wind.

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where \( f \) (in Hz) is the natural frequency of the chimney on its foundations. This may be calculated analytically or from the following approximate formula for the case of a regular cone:

\[
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\]

and

- \( h \) is the height of chimney (in m)
- \( D_i \) is the diameter at top (in m)
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\[
V = 40 \sqrt{g}
\]

where \( g \) is the design wind pressure in kN/m², severe vibration is unlikely and no further calculation is required.

**(c)** If \( V_{crit} \) is less than the design wind velocity, the tendency to oscillate \( C \) may be estimated by the following empirical formula:

\[
C = 0.6 + K \left( \frac{10D_i^2}{W} - 1.5 \frac{\Delta}{D_i} \right)
\]

where

- \( \Delta \) is the calculated deflection (in m) at the top of the chimney for unit distributed load of 1 kPa
- \( K \) is 3.0 for all welded construction, 3.0 for welded with flanged and bolted joints and 2.5 for bolted and riveted or all riveted.

**(d)** If \( C \) is less than 1.0, severe vibration is unlikely. If \( C \) is between 1.0 and 1.3 the design wind pressure for the chimney should be increased by a factor \( C^* \). If \( C \) is larger than 1.3 stabilizers or dampers should be provided to control the vibrations.

The terms “oscillation” and “vibration” are collectively read as “vibration” for consistency.
### Serviceability issues

The following serviceability issues shall be addressed for long span structures:

- **(a)** Vibration from crowds. Refer to section 5 of the Code.
- **(b)** Wind induced oscillations of roof elements and cables. Fatigue may need to be checked.
- **(c)** Access for maintenance of roof stonework can be very difficult therefore a high quality protective system should be specified for the stonework.
- **(d)** Deflection limits for long span trusses under live and wind loads depend on circumstances. A value of span/300 may be used for temporary design in the absence of other requirements. Significantly smaller deflection limits will be required for applications such as: aircraft hanger doors and stadia opening roofs.

The terms “oscillation” and “vibration” are collectively read as “vibration” for consistency.

### Vibration and oscillation

Pedestrians can be adversely affected by the dynamic behaviour of footbridges. In addition to the criteria specified in section 5 on Human-Induced Vibration, the natural frequency of a footbridge shall not be less than 3 Hz. If the natural frequency of a footbridge is less than 3 Hz which may lead to unpleasant vibration, the maximum vertical acceleration, \( a \), shall be limited to an appropriate value as given in recognized design guidelines in Annex A2.3 in order to avoid unpleasant vibration.

The terms “oscillation” and “vibration” are collectively read as “vibration” for consistency hence the word “oscillation” is deleted.

### Chinese standards

<table>
<thead>
<tr>
<th>Chinese standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB/T 247 - 1997</td>
</tr>
<tr>
<td>GB/T 709 - 2006</td>
</tr>
<tr>
<td>GB/T 1591 - 2008</td>
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<tr>
<td>GB/T 5313 - 1985</td>
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<td>GB/T 4104 - 2000</td>
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<td>GB 50017 - 2003</td>
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<td>GB 50205 - 2001</td>
</tr>
</tbody>
</table>

Rules of acceptance, package, label and certification for plate, strip and wide flat in structural steel.

The Chinese standard GB/T 700-2006 is added in the Acceptable Standard List.

<table>
<thead>
<tr>
<th>Chinese standards</th>
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</thead>
<tbody>
<tr>
<td>GB/T 247 - 1997</td>
</tr>
<tr>
<td>GB/T 709 - 2006</td>
</tr>
<tr>
<td>GB/T 1591 - 2008</td>
</tr>
<tr>
<td>GB/T 5313 - 1985</td>
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<tr>
<td>GB/T 4104 - 2000</td>
</tr>
<tr>
<td>GB 50017 - 2003</td>
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<td>GB 50205 - 2001</td>
</tr>
</tbody>
</table>


Dimension, appearance, weight and tolerance of plate, strip and wide flat in hot rolled structural steel.

High strength structural steel.

Steel plate for high rise building structure.

Code for design of steel structures.

Code for acceptance of construction quality of steel structures.