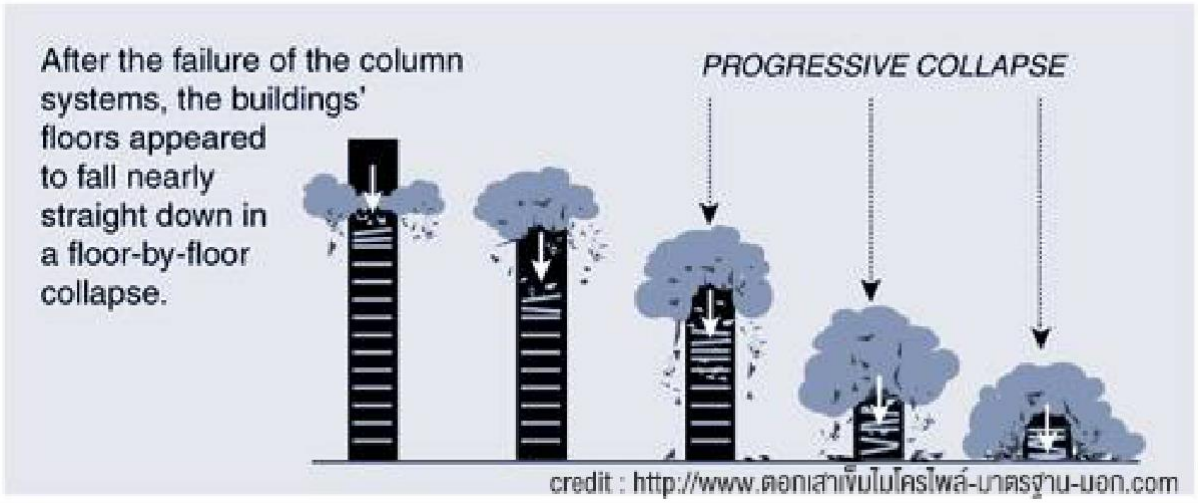
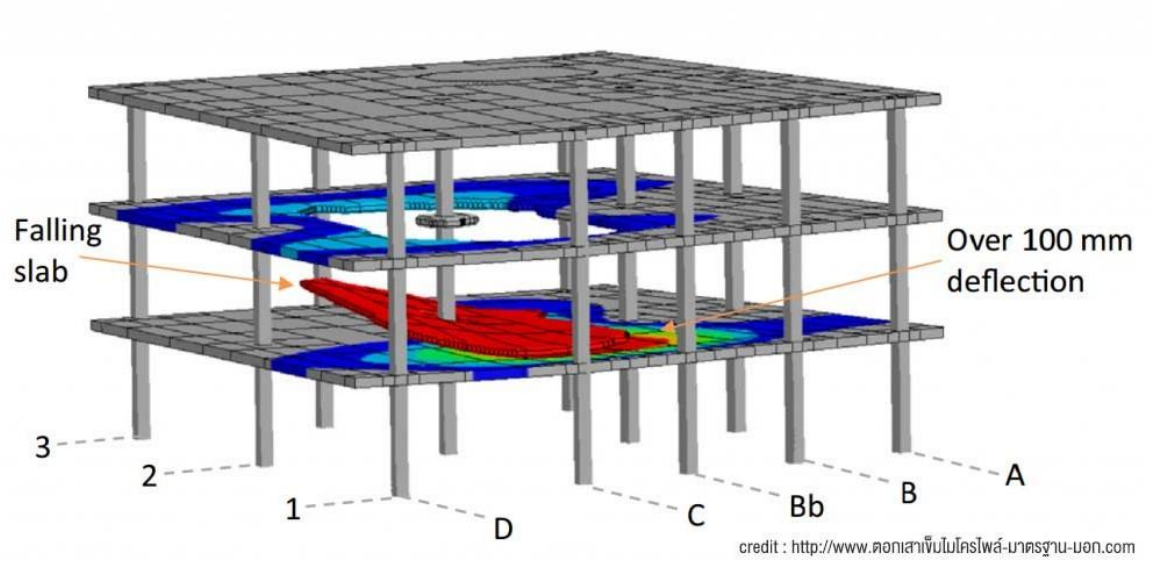
Progressive Collapse Preventing Rebar



In the design of flat plate in various parts of Thailand, it has been always asked that which province should the progressive collapse preventing rebar be provided? Don't some provinces need this type of rebar? To answer these questions, firstly, we have to understand about the role of progressive preventing rebar. This rebar plays a very important role in a slab failure prevention. Once the slab fails because of the external load is greater than its allowable strength, the progressive collapse preventing rebar will carry and prevent the slab not to fall down on consumers who stay below or on the lower story slab which will cause the lower slab fails and fall down floor-by floor until the base of buildings.

Next, study on the regulations and design standards about the properties of progressive collapse preventing rebar. In the Ministerial Regulations on load resistance, stiffness, durability and supported area of buildings to resist against earthquake, B.E 2550, **Section 4** specifies that the design of buildings in accordance with the Ministerial Regulation, **Section 3**, the designer must consider that the ductility of the entire structural systems has to be equal to the limited ductility in accordance with the Standard for earthquake Resistant Design of Buildings (DPT 1301-54). It means that the progressive collapse preventing rebar shall be provided and not less than $A_{sm} = \frac{0.5 w_u L_1 L_2}{0.9 f_y}$ which specified in **Section 4.8** of DPT 1301-54.



Revision to the Ministerial Regulation, **Section 3**, types and location of structures which the progressive collapse preventing rebar shall be considered can be summarized as in the **Table** below.

No.	Type of Rebar	Design Specification
1	Minimum bonded reinforcement in negative moment areas at column supports	TIS 1009-34, Section 3.4.2.1 (ข); ACI318 before and until ACI318-11, Section 18.9.3.3; ACI 318-14, Section 8.6.2.3
2	Bottom deformed reinforcement and progressive collapse protection	DPT 1301-54, Section 4.8; ACI 318-08 and after, Section 18.12.7; ACI 318-14, Section 8.7.5.6.3
3	Shear reinforcement in slab	TIS 1008-38, Section 4412(ค); ACI 318 before and until ACI 318-05, Section 11.12.3; ACI 318-08 until ACI 318-11, Section 11.11.3

		and 21.13.6; ACI 318-14, Section 8.7.6 and 18.14.5
4	Minimum bonded reinforcement in positive moment areas	TIS 1009-34, Section 3.4.2.1(ก); ACI 318 before and until ACI 318-11, Section 18.9.3.2; ACI 318-14, Section 8.6.2.3
5	Minimum reinforcement for column capital, drop panel and band beam	TIS 1008-38, Section 3412; ACI 318 before and until ACI 318-11, Section 7.12; ACI 318-14, Section 7.6
6	Pour strip	Manual Calculation
7	Reinforcement along perimeter of shear wall lifts	Manual Calculation
8	Special reinforcement at perimeter or corners of opening slabs	Typical Detail
9	Anti-bursting reinforcement	Typical Detail
10	Other special reinforcements	Typical Detail

*__Surveillance Area__ = Some areas which may be hit by earthquake such as Krabi, Chumphon, Phang Nga, Rayong, Ranong, Songkhla and Surat Thani.

Area 1 = All areas consisted of soft subsoils which may easily get affected by large scale distant earthquake such as Bangkok, Nonthaburi, Pathum Thani, Samut Prakan and Samut Sakhon.

Area 2 = All areas near active faults which may be get affected from earthquake such as Kanchanaburi, Chiang Rai, Chiang Mai, Tak, Nan, Phayao, Phrae, Mae Hong Son, Lam Pang and Lam phun.

For other locations out of surveillance area, Area 1 and Area 2 which specified in the Ministerial Regulation, it is not yet sure that the progressive collapse preventing rebar shall be provided or not since it does not have any discussion about this problem in the standard of building designs of Thailand. However, ACI318-08, which is updated continuously, **Section 18.12.6** provided the general specification on post-tensioned slab system design that in slabs with unbonded tendons, a minimum of 12.7 mm diameter or larger, seven-wire post tensioned strands shall be provided in each direction at columns, either passing through or anchored within the region bounded by the longitudinal reinforcement of the column. **Section 18.12.7** specifies that in case slabs with bonded system, if the strands could not be placed pass through columns, they shall be provided by bottom reinforcement in each direction passing within the region bounded by the longitudinal reinforcement of the column and anchored at exterior supports not less than $\frac{\mathbf{0.795}\sqrt{f'_c}}{f_y} \cdot \boldsymbol{b} \cdot \boldsymbol{d}$ and not less than $\frac{\mathbf{21}}{f_y} \cdot \boldsymbol{b} \cdot \boldsymbol{d}$. This means that the progressive collapse preventing rebar shall be provided, however, this amount of rebar is less than the one specified by DPT 1301-54.

In real design, ACI 318 is the designed specification specified by the designers in the design criteria. Some designers may use ACI issued before 2008 which does not discuss about the providing of bottom reinforcement in post-tension slab design. The reason that ACI 318-08 provides this reinforcement is to provide the security to consumers and to prevent from the

progressive collapse even though it does not help in the behavior of load resistance of the structures. Moreover, it shall explain to the owners or consumers of buildings to understand about the advantages and roles of the progressive collapse preventing rebar which acts like an airbag of a car. This airbag does not help to increase the speed of the car, does not improve the power of the engine; however, it helps the driver to be safe when the accident happens. Therefore, the owner has the right to choose whether he or she needs this airbag or not.

Prepared by: P.E Parkpoome Vanitkamonnunt