ADAPT

STRUCTURAL CONCRETE SOFTWARE SYSTEM

ADAPT-PT/RC® v20

NEW FEATURES SUPPLEMENTAL MANUAL

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Introduction

This supplemental manual provides descriptions of ADAPT-PT/RC's latest features and enhancements. These new features have been introduced to meet the needs for general analysis, design, and reporting capabilities and to increase productivity and efficiency in program use.

New Features

New Design Codes – ACI 318-2019

The program has been updated to include applicable provisions from ACI318-19: Building Code Requirements for Structural Concrete. Those provisions in the latest design standard that have been included in ADAPT-PT/RC include:

- Reinforcement strain limit has been revised for all criteria and system types (beam, one-way and two-way slabs for RC and PT mode).

  ACI 318-19, 7.3.3.1 states that non-prestressed slabs shall be tension-controlled in accordance with Table 21.2.2.

  ACI 318-14 stated that for non-prestressed slabs, εt, shall be at least 0.004.

- Minimum flexural reinforcement for non-prestressed, reinforced one- and two-way slabs shall meet a minimum area of flexural reinforcement of 0.0018Ag. See ACI318-19, 7.6.1.1.

- For two-way non-prestressed, reinforced concrete slabs the equation for modulus of rupture is modified for f_y exceeding 80,000 psi. ACI 318-19, 8.3.1.1 states that for fy exceeding 80,000 psi, the calculated deflection limits in 8.3.2 shall be satisfied assuming a reduced modulus of rupture, fr = 5*f'c^$^{1/2}$. This change applies to cracked deflection calculations in the program where fr is used to calculate cracking moments, Mcr.

- Minimum extensions for deformed reinforcement were revised per ACI 318-19, Figure 8.7.4.1.3 for deformed reinforcement in two-way slabs without beams such that the 50% of column strip top reinforcement shall be as defined in ACI 318-14, but not less than 5d where d is the distance from the extreme compression fiber to centroid of longitudinal tension reinforcement. The algorithm for bar curtailment in BuilderSum was adjusted. In case code ACI 2019 and curtailment rules is ACI, top bar curtailment is extended to 5*D.

- The reinforcement strain limit for beams was revised per ACI 318-19, 9.3.3.1. This section states that "Non-prestressed beams with Pu < 0.10(f'cAg) shall be tension-controlled in accordance with Table 21.2.2."

- For the calculation of the minimum flexural reinforcement amount for beams with fy exceeding 80,000 psi, ACI 318-19, 9.6.1.2 states that the value of fy shall be limited to a maximum of 80,000 psi.

Table 9.7.6.2.2—Maximum spacing of legs of shear reinforcement

Required V_s		Maximum *s*, mm			
		Nonprestressed beam		Prestressed beam	
		Along length	Across width	Along length	Across width
$\leq 0.33\sqrt{f_c'}b_w d$	Lesser of:	$d/2$	d	$3h/4$	$3h/2$
		600			
$> 0.33\sqrt{f_c'}b_w d$	Lesser of:	$d/4$	$d/2$	$3h/8$	$3h/4$
		300			

- One-way shear strength provisions for non-prestressed members in relation with Vc for non-prestressed members have been modified per ACI 318-19, 22.5.5.1. This section states that for non-prestressed members, Vc shall be calculated by Table 22.5.5.1 and sections 22.5.5.1.1 through 22.5.5.1.3.

Table 22.5.5.1—V_c for nonprestressed members

Criteria	V_c		
$A_v \geq A_{v,min}$	Either of:	$\left[0.17\lambda\sqrt{f_c'} + \frac{N_u}{6A_g}\right]b_w d$	(a)
		$\left[0.66\lambda(\rho_w)^{1/3}\sqrt{f_c'} + \frac{N_u}{6A_g}\right]b_w d$	(b)
$A_v < A_{v,min}$	$\left[0.66\lambda_s\lambda(\rho_w)^{1/3}\sqrt{f_c'} + \frac{N_u}{6A_g}\right]b_w d$		(c)

Notes:
1. Axial load, N_u, is positive for compression and negative for tension.
2. V_c shall not be taken less than zero.

The new Table 22.5.5.1 introduces a criterion for Av and Av,min, that results in a set of equations to calculate Vc.

  - ACI 318-19, 22.5.5.1.1 states Vc shall not be great than 5*f'c^$^{0.5*}$bw*d.

- ACI 318-19, 22.5.5.1.2 states that the value of Nu / 6*Ag shall not be taken greater than 0.05 f'c.
- ACI 318-19, 22.5.5.1.3 introduces a new size modification factor to be included when Av<Av,min.

$$\lambda_s = \sqrt{\frac{2}{1+\frac{d}{10}}} \leq 1$$

- The requirements for Av,min for non-prestressed and prestressed beams are given in ACI318-19, 9.6.3.1 and 9.6.3.2. The provisions have changed from older version of the code. The program has been modified to include the provisions found below for non-prestressed beams.

9.6.3.1 For nonprestressed beams, minimum area of shear reinforcement, $A_{v,min}$, shall be provided in all regions where $V_u > \phi\lambda\sqrt{f_c'}\,b_w d$ except for the cases in Table 9.6.3.1. For these cases, at least $A_{v,min}$ shall be provided where $V_u > \phi V_c$.

Table 9.6.3.1—Cases where $A_{v,min}$ is not required if $V_u \leq \phi V_c$

Beam type	Conditions
Shallow depth	$h \leq 10$ in.
Integral with slab	$h \leq$ greater of $2.5t_f$ or $0.5b_w$ and $h \leq 24$ in.
Constructed with steel fiber-reinforced normalweight concrete conforming to 26.4.1.5.1(a), 26.4.2.2(i), and 26.12.7.1(a) and with $f_c' \leq 6000$ psi	$h \leq 24$ in. and $V_u \leq \phi 2\sqrt{f_c'}b_w d$
One-way joist system	In accordance with 9.8

For prestressed beams they are as follows:

9.6.3.2 For prestressed beams, a minimum area of shear reinforcement, $A_{v,min}$, shall be provided in all regions where $V_u > 0.5\phi V_c$ except for the cases in Table 9.6.3.1. For these cases, at least $A_{v,min}$ shall be provided where $V_u > \phi V_c$.

The calculation for minimum shear reinforcement Av,min remain similar to previous code editions and are as follows:

Table 9.6.3.4—Required $A_{v,min}$

Beam type	$A_{v,min}/s$			
Nonprestressed and prestressed with $A_{ps}f_{se} < 0.4(A_{ps}f_{pu} + A_sf_y)$	Greater of:	$0.75\sqrt{f'_c}\dfrac{b_w}{f_{yt}}$		(a)
		$50\dfrac{b_w}{f_{yt}}$		(b)
Prestressed with $A_{ps}f_{se} \geq 0.4(A_{ps}f_{pu} + A_sf_y)$	Lesser of:	Greater of:	$0.75\sqrt{f'_c}\dfrac{b_w}{f_{yt}}$	(c)
			$50\dfrac{b_w}{f_{yt}}$	(d)
		$\dfrac{A_{ps}f_{pu}}{80f_{yt}d}\sqrt{\dfrac{d}{b_w}}$		(e)

- The calculation of Vc for prestressed members has been modified for those members where the full effective prestress force has been transferred to concrete. ACI318-19, 22.5.6.2 in now considered as shown below.

22.5.6.2 For prestressed flexural members with $A_{ps}f_{se} \geq 0.4(A_{ps}f_{pu} + A_sf_y)$, V_c shall be calculated in accordance with Table 22.5.6.2, but need not be less than $2\lambda\sqrt{f'_c}\,b_wd$. Alternatively, it shall be permitted to calculate V_c in accordance with 22.5.6.3.

Table 22.5.6.2—Approximate method for calculating V_c

V_c		
Least of (a), (b), and (c):	$\left(0.6\lambda\sqrt{f'_c} + 700\dfrac{V_ud_p}{M_u}\right)b_wd$ [1],[2]	(a)
	$(0.6\lambda\sqrt{f'_c} + 700)b_wd$	(b)
	$5\lambda\sqrt{f'_c}b_wd$	(c)

[1] M_u occurs simultaneously with V_u at the section considered.

[2] When calculating the V_ud_p/M_u term in Eq. 22.5.6.2(a), d_p is the distance from the extreme compression fiber to the centroid of prestressed reinforcement. It shall not be permitted to take d_p as $\mathbf{0.80}h$ as in 22.5.2.1.

- For two-way shear of slabs, a new size effect factor, λ is introduced in the allowable concrete shear stress, Vc, without shear reinforcement. ACI 318-19, Table 22.6.5.2 now incorporates the size effect factor, λ_s in equations (a), (b), and (c).

Table 22.6.5.2—v_c for two-way members without shear reinforcement

v_c		
Least of (a), (b), and (c):	$4\lambda_s\lambda\sqrt{f'_c}$	(a)
	$\left(2+\frac{4}{\beta}\right)\lambda_s\lambda\sqrt{f'_c}$	(b)
	$\left(2+\frac{\alpha_s d}{b_o}\right)\lambda_s\lambda\sqrt{f'_c}$	(c)

Notes:
(i) λ_s is the size effect factor given in 22.5.5.1.3.
(ii) β is the ratio of long to short sides of the column, concentrated load, or reaction area.
(iii) α_s is given in 22.6.5.3.

This change accounts for the impact of depth effects on two-way shear capacity of concrete without shear reinforcement. For slabs over 10" in depth, the calculation of Vc will be reduced as compared to previous code versions. The size factor is the same as introduced above in the one-way shear modifications.

$$\lambda_s = \sqrt{\frac{2}{1+\frac{d}{10}}} \leq 1$$

- For the check of cracked deflections at service level conditions, the effective moment of inertia, I_e equations have been revised for non-prestressed members.

  ACI 318-19, 24.2.3.5 states that for non-prestressed members, unless obtained by a more comprehensive analysis, effective moment of inertia (Ie) shall be calculated in accordance with Table 24.2.3.5.

$$M_{cr} = \frac{f_r I_g}{y_t} \qquad (24.2.3.5)$$

Table 24.2.3.5—Effective moment of inertia, I_e

Service moment	Effective moment of inertia, I_e, in.^{4}	
$M_a \le (2/3)M_{cr}$	I_g	(a)
$M_a > (2/3)M_{cr}$	$\dfrac{I_{cr}}{1-\left(\dfrac{(2/3)M_{cr}}{M_a}\right)^2\left(1-\dfrac{I_{cr}}{I_g}\right)}$	(b)

In ACI 318-19, R24.2.3.5, the effective moment of inertia approximation developed by Bischoff and Scanlon is adopted and Branson equation (ACI 318-14, Eq. 24.2.3.5a) is removed from ACI 318-19.

For prestressed members, the provisions found in ACI318-14 continue to apply and are described in ACI318-19, 24.2.3.9.

24.2.3.9 For prestressed Class T and Class C slabs and beams as defined in 24.5.2, deflection calculations shall be based on a cracked transformed section analysis. It shall be permitted to base deflection calculations on a bilinear moment-deflection relationship or I_e in accordance with Eq. (24.2.3.9a)

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1-\left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr} \qquad (24.2.3.9a)$$

where M_{cr} is calculated as

$$M_{cr} = \frac{(f_r + f_{pe}) I_g}{y_t} \qquad (24.2.3.9b)$$

Enhancements

Punching Shear

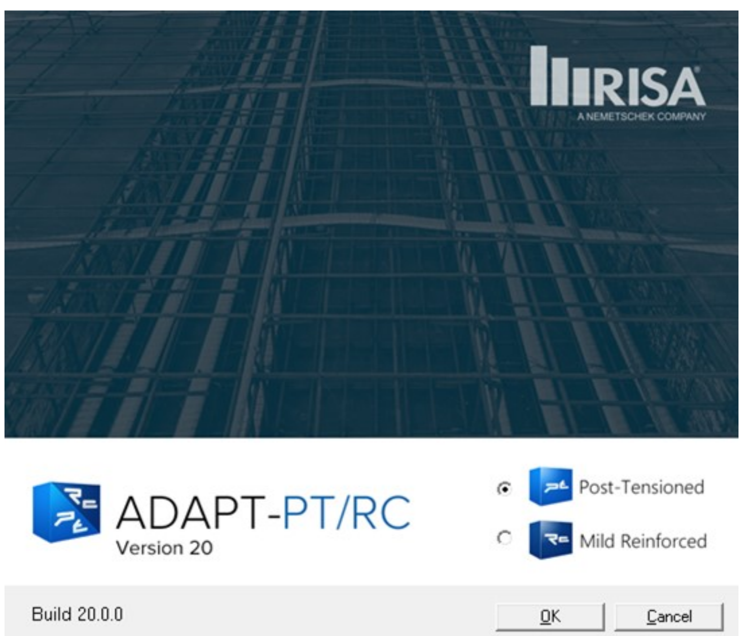
An improvement was made to the punching shear check when the seismic drift option is enabled from the Floor Design>Shear Design. When checking critical sections outside of the shear-reinforced zone (octagonal-shaped sections) the program was using the section critical area for determining reinforcement necessary to meet the drift requirement. This resulted in increasing reinforcement moving away from the support face. The critical section to be used for all locations within 4*h from column face is the first critical section area at d/2 from support face. (Item 7414)

One-Way Shear

An improvement was made to handling of minimum reinforcement for one-way RC slabs per ACI318-14 Section 7.6.1.1. In prior versions minimum flexural reinforcement for beams was also being applied to one-way RC slabs as was the requirement to limit minimum reinforcement to 1.33*As,ult when As,min>As,ult.

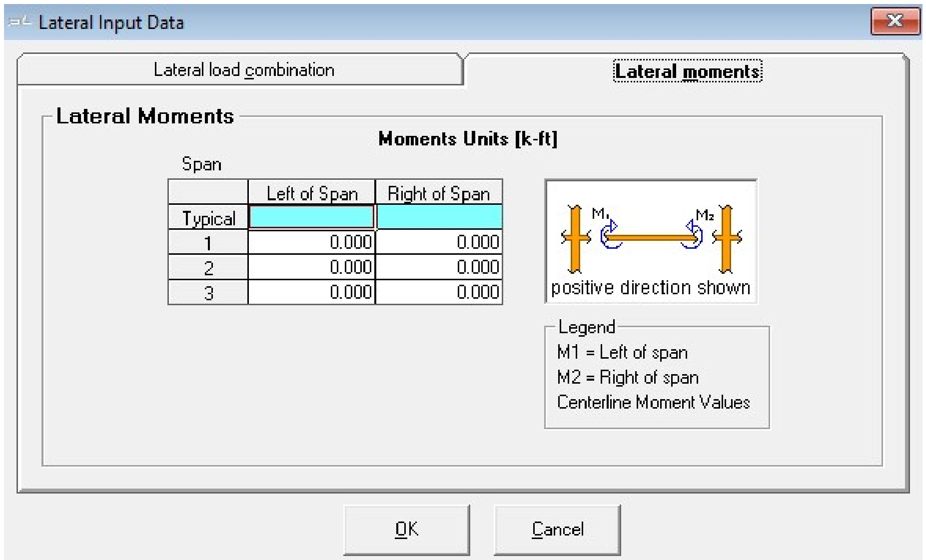
User Interface

The program now includes new version formatting in images, reporting and other dialogues referencing **ADAPT-PT/RC 20**.

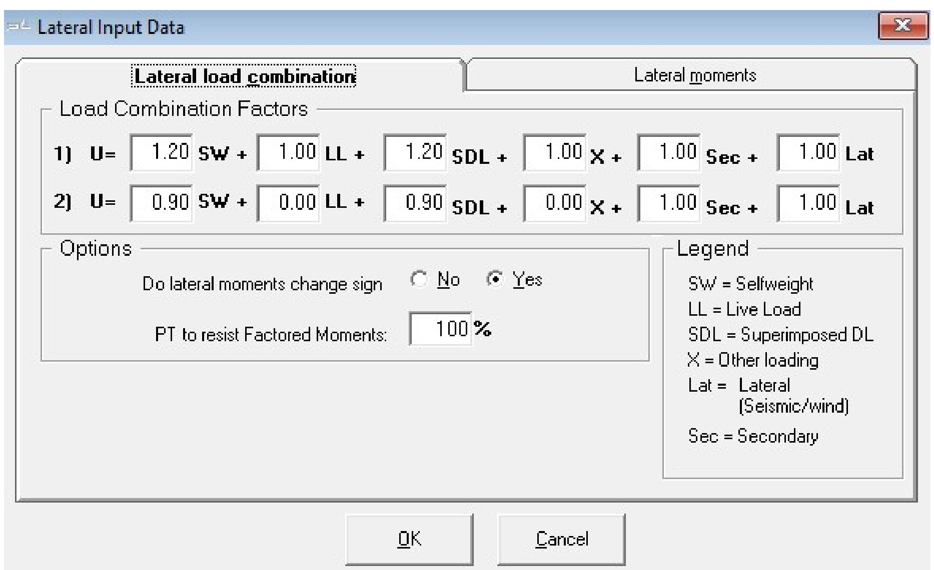


Lateral Load Defaults

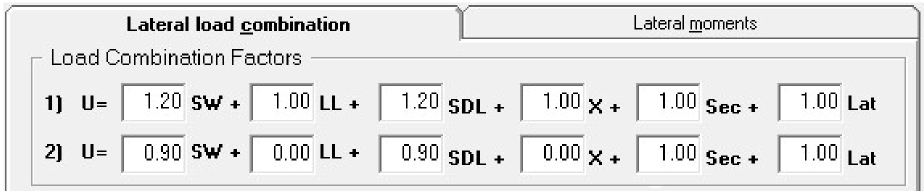
The lateral load input window includes new notation stating that lateral joint moments are to be inserted as centerline moments, not those at face of support.



The default for Lateral load reversal is now set to YES for enveloping inclusivity.



The Lateral load factors in the lateral load combinations was defaulted to 1.0 from 1.6 as per seismic and wind loads being generated at ultimate force level.



Analysis/Design

EC2 Design Code – As it relates to strut and tie method for shear design, the moment value resolution at end spans and the interpretation of these moments for additional longitudinal reinforcement due to axial tension from internal forces when inclined stirrups are used for the EC2 design code.

Licensing

ADAPT-PT/RC 20 was improved for the use of cloud and network licensing options offered by RISA. Future management and updates to ADAPT-PT/RC licenses will be handled by the same web-based management system used for all other RISA products.