Florida Public Hurricane Loss Model

Per Standard C-4.F, this document relates equations terms to source code implementation variable names for each model change identified in Standard G-1, Disclosure 5 that involves software development.

Changes to FPHLM V5.0 to become FPHLM V6.0

1. Changes in the low-rise commercial residential model (LR-CR) of the Engineering Component

1.1. Projectile count increase in debris impact (Table 1)

Table 1: Projectile count increase in debris impact

Variable Name or Term in Documentation	Variable Name in Code	Description
1) Main Monte Carlo Engine File: MAIN_DRIVER_4_14.m		
Number of Shingles	Number_of_Shingles	Number of shingle tabs on the roof (count)
Width	Width	The width of the roof area perpendicular to the roof line (ft)
Length	Length	The length of the roof area parallel to the roof line (ft)
Area Slope	Area_Slope	The total roof area taking into consideration the slope of the roof. (ft^2)
Mean Shingle Width	Mn_ShingleWidth	The mean width of a single shingle tab (ft)
Mean Shingle Length	Mn_ShingleLength	The mean length of a shingle tab (ft)
2) Calculates the number of available missile File: Numberofavailablemissileobjects.m		
Number of Missiles	NA	The total number of available missiles to hit the building

1.2. Change in the interior pressure sharing between attic and top floor (Table 2)

Table 2: Interior pressure calculations

Variable Name or Term in Documentation	Variable Name in Code	Description
Enclosure condition routine for "Gable" and "Hip" roofs Files: ENCLOSURECONDITIONUPDATER_GABLE_SIGN.m and ENCLOSURECONDITIONUPDATER_HIP_SIGN.m		
Attic internal pressure	GCpi_Attic	A scalar value. Internal pressure of the attic space ("_orig" used to save the original value)
Internal pressure	GCpi	A vector. Internal pressure of the individual floors of the building ("_orig" used to save the original value)
Number of Stories	TotalNumberofStories	Total number of stories used to identify the value of the pressure coefficient on the top story of the building.

1.3. Change in the interior pressure calculation in the attic space due to sheathing loss (Table 3)

Table 3: Interior pressure calculation in the attic space

Variable Name or Term in Documentation	Variable Name in Code	Description
Enclosure condition routine for "Gable" and "Hip" roofs Files: ENCLOSURECONDITIONUPDATER_GABLE_SIGN.m andENCLOSURECONDITIONUPDATER_HIP_SIGN.m		
Number of Shingles	GCpi_Attic	Number of shingle tabs on the roof (count)
Zone 4 External Positive Pressure Coefficient	GCp_zone4_POSITIVE	The width of the roof area perpendicular to the roof line (ft)
Zone 4 External Negative Pressure Coefficient	GCp_zone4_NEGATIVE	The length of the roof area parallel to the roof line (ft)
Leeward Envelope Area Opening	AreaOpenEnvelopeBalanceAttic	The total roof area taking into consideration the slope of the roof. (ft^2)
Windward Envelope Area Opening	AreaOpenWindwardAttic	The mean width of a single shingle tab (ft)

1.4. Change in soffit damage computation (Table 4)

Table 4: Soffit damage computation

Variable Name or Term in Documentation	Variable Name in Code	Description
Soffit damage calculation routine File: Soffit_Pressure_Damage.m		
Load on wall 1 and 2	Load_Wall1 and Load_Wall2	A scalar value. Internal pressure of the attic space
External Positive Pressure Coefficient	GCp_Positive	ASCE 7-05 definition for zone 4 positive roof pressure coefficient
External Negative Pressure Coefficient	GCp_Negative	ASCE 7-05 definition for zone 4 negative roof pressure coefficient
Attic internal pressure	GCpi_Attic	A scalar value. Internal pressure of the attic space
Windward Envelope Area Opening	COV_Cp	Coefficient of variation for Cp values
Mean eave windspeed	WindSpeeds_mean_EaveHeight	Log adjusted wind speed at the eave height (mph)

1.5. Reduction in the pressure coefficient (Cp) multiplier (Table 5)

Table 5: Pressure coefficient (Cp) multiplier

Variable Name or Term in Documentation	Variable Name in Code	Description
1) Main Monte Carlo Engine File: MAIN_DRIVER_4_14		
CP Factor	CP_Factor	The reduction factor for the ASCE7-05 coefficient of pressure
2) ASCE Wall Pressure File: WALLPRESSURECOEFFASCE.m		
CP Factor	CP_Factor	The reduction factor for the ASCE7-05 coefficient of pressure
Pressure coefficient	GCp	ASCE 7-05 coefficient of pressures

1.6. Modification of the masonry wall area failure function and its differentiation between unreinforced and reinforced masonry (Table 6)

Table 6: Masonry wall function index

Variable Name or Term in Documentation	**Variable Name in Code**	**Description**
Masonry Wall function File: IntExt_calc_CL_V60		
$lim_{MaxFlexure}$	Pre_limit_max_flex = Post_limit_min_flex	Damage percentage equivalent when exceedance ratio =1, max value for quadratic equation for flexure
$lim_{MaxShear}$	Pre_limit_max_shear = Post_limit_min_shear	Damage percentage equivalent when exceedance ratio =1, max value for quadratic equation for shear
$X_{Flexure}$	DP(:,[15:18 35:38 55:58],:,:)	Columns in the damage matrix output file (DP) which stor all the load/capacity ratios for flexural failure
X_{Shear}	DP(:,[11:14 31:34 51:54],:,:)	Columns in the damage matrix output file (DP) which stor all the load/capacity ratios for flexural failure
%DamageFlexure	sub_array	Converted load/capacity ratios saved as % of damage for flexure
%DamageShear	sub_arraya	Converted load/capacity ratios saved as % of damage for shear

1.7. Changes in the rain admittance factor (RAF) values and incorporation of the new surface run-off coefficient. (Table 7)

1.8. Replacement of the directionality factor (fsim) with a more sophisticated directionality scheme. (Table 7)

Table 7: Rain Intrusion calculations

Variable Name or Term in Documentation	**Variable Name in Code**	**Description**
1) Water intrusion through Breached Roof Cover File: IntExt_calc_CL_V60		
$Area_{panel}$	AreaPanel	Area of one sheathing panel (4' x 8') (ft^2)
$Area_{Roof}$	AreaRoof	Roof area (ft^2)
$Area_{Total}$	AreaBase	total living area per floor (ft^2)
$A_{SR\theta}$	A0,A45,A90	Reference surface runoff area for one sheathing panel at wind angle θ (ft^2)
A_{ref}	A_{ref}	reference vector (1x8) containing all indexed Asr values
βj	beta(j)	portion of HR_2 that falls in octant *j* during storm rotation
Def_{Sheath}	DefSheathngRf	Density of defects in exposed roof sheathing(gaps around sheathing panels)
DI_*Breach*	DI_*Breach*	Contribution of Direct impinging rain through breach
$ED_{RoofCover}$	ExtDam(:,1)	Exterior damage of Roof cover. (%)
$ED_{RoofSheath}$	ExtDam(:,2)	Exterior damage of Roof sheathing. (%)
$f\log law(stories)$	Floglaw	wind profile reduction to translate reference wind speed height to model height
fPerc	Fperc	percolation from story to story. (%)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
L_1	WidthFLR+2xWidthOverhang	Reference length = horizontal projection roof length (ft)
L_2	LengthFLR+2xWidthOverhan g	Reference width = horizontal projection roof width (ft)
MembR	MembR	Additional Membrane Reduction factor for Strong HVHZ models
Num_pan	Num_pan	number of sheathing panels exposed to surface runoff
$\overline{RAF}_{\theta j}$	RAF_roof	Mean Rain Admittance Factor at wind direction θ.

$\overline{SRC}_{\theta j}$	SRC_roof	Mean Surface Runoff Coefficient at wind direction θ
SR_*Breach*	SR_*Breach*	Contribution of Surface runoff Rain on breach
wat(stories)	wat	Total height of water from damage source on a given story floor
2) Water intrusion through Breached Roof Sheathing File: IntExt_calc_CL_V60		
$Area_{panel}$	AreaPanel	Area of one sheathing panel (4' x 8') (ft^2)
$Area_{Roof}$	AreaRoof	Roof area (ft^2)
$Area_{Total}$	AreaBase	total living area per floor (ft^2)
$A_{SR\theta}$	A0,A45,A90	Reference surface runoff area for one sheathing panel at wind angle θ (ft^2)
A_{ref}	A_{ref}	reference vector (1x8) containing all indexed Asr values
βj	beta(j)	portion of HR_2 that falls in octant *j* during storm rotation
Def_{Sheath}	DefSheathngRf	Density of defects in exposed roof sheathing(gaps around sheathing panels)
DI_*Breach*	DI_*Breach*	Contribution of Direct impinging rain through breach
$ED_{RoofCover}$	ExtDam(:,1)	Exterior damage of Roof cover. (%)
$ED_{RoofSheath}$	ExtDam(:,2)	Exterior damage of Roof sheathing. (%)
$f\log law(stories)$	Floglaw	wind profile reduction to translate reference wind speed height to model height
fPerc	Fperc	percolation from story to story. (%)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
L_1	WidthFLR+2xWidthOverhang	Reference length = horizontal projection roof length (ft)
L_2	LengthFLR+2xWidthOverhan g	Reference width = horizontal projection roof width (ft)
MembR	MembR	Additional Membrane Reduction factor for Strong HVHZ models
Num_pan	Num_pan	number of sheathing panels exposed to surface runoff
$\overline{RAF}_{\theta j}$	RAF_roof	Mean Rain Admittance Factor at wind direction θ.
$\overline{SRC}_{\theta j}$	SRC_roof	Mean Surface Runoff Coefficient at wind direction θ
SR_*Breach*	SR_*Breach*	Contribution of Surface runoff Rain on breach

wat(stories)	Wat	Total height of water from damage source on a given story floor
3) Total water intrusion through gable end cover File: IntExt_calc_CL_V60		
$Area_{Defects}$	Adef	Area of Gable end defects (ft^2)
$Area_{Total}$	AreaBase	total living area (ft^2)
$A_{SR\theta}$	A0,A45,A90	Reference surface runoff area for gable end at wind angle θ (ft^2)
A_{ref}	Aref	reference vector (1x8) containing all indexed Asr values
β_j	beta(j)	portion of HR_2 that falls in octant *j* during storm rotation
$Defect_{Sheath}$	defSheathng	Density of defects in exposed gable end (gaps around sheathing panels)
$ED_{GableCover}$	ExtDam(:,7:8)	Exterior damage of Gable cover. (%)
$ED_{GagleSheath}$	ExtDam(:,9:10)	Exterior damage of Gable sheathing. (%)
$f\log law(stories)$	fLogLaw	wind profile reduction to translate reference wind speed height to model height
fPerc	Fperc	percolation from story to story. (%)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
$\overline{RAF}_{\theta j}$	RAF_gbl	Mean Rain Admittance Factor on Gable end at wind direction θ.
$\overline{SRC}_{\theta j}$	SRC_gbl	Mean Surface Runoff Coefficient on Gable end at wind direction θ
SR_*Breach*	SR_*Breach*	Contribution of Surface runoff Rain on breach
wat(stories)	wat	Total height of water from damage source on a given story floor.
4) Total water intrusion through gable end sheathing File: IntExt_calc_CL_V60		
$Area_{gable}$	AreaGable	Area of undamaged Gable end (ft^2)
$Area_{Total}$	AreaBase	total living area (ft^2)
$A_{SR\theta}$	A0,A45,A90	= Reference surface runoff area for gable end at wind angle θ (ft^2)
A_{ref}	Aref	reference vector (1x8) containing all indexed Asr values
β*j*	beta(j)	portion of HR_2 that falls in octant *j* during storm rotation
DI_*Breach*	DI_*Breach*	Contribution of Direct impinging rain through breach
$ED_{GagleSheath}$	ExtDam	Exterior damage of Gable sheathing. (%)

$f \log law(stories)$	fLogLaw	wind profile reduction to translate reference wind speed height to model height
fPerc	fPerc	percolation from story to story. (%)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
H_{mean}	*meanRoofHeight*	Mean Roof Height
$\overline{RAF}_{\theta j}$	*RAF_gbl*	Mean Rain Admittance Factor on Gable end at wind direction θ.
$\overline{SRC}_{\theta j}$	*SRC_gbl*	Mean Surface Runoff Coefficient on Gable end at wind direction θ
SR_*Breach*	SR_*Breach*	Contribution of Surface runoff Rain on breach
wat(stories)	wat	Total height of water from damage source on a given story floor.
5) Water intrusion through wall cover File: IntExt_calc_CL_V60		
$Area_{defects\_BrN}$	Adef_BrN	Area of exposed defects in wall sheathing due to breaches in the wall cover (ft^2)
$Area_{defects\_DfN}$	Adef_DfN	Area of existing defects in undamaged wall cover (ft^2)
$Area_{Total}$	Areabase	total living area (ft^2)
$A_{SR\theta\_BrN}$	A_SRC_BrN	Reference surface runoff area that facilitates runoff for exposed breaches at wind angle θ (ft^2)
$A_{SR\theta\_DfN}$	A_SRC_DfN	Reference surface runoff area that facilitates runoff for exposed defects at wind angle θ (ft^2)
α_i	alpha(i)	portion of HR_1 that falls in octant *i* during storm rotation
β_j	beta(j)	portion of HR_2 that falls in octant *j* during storm rotation
$Defects_{Cover}$	DefWallPtrCrk	Density of cracks in wall cover
$Defects_{sheathing}$	DefSheathng	Density of gaps in exposed wall material
$ED_{WallCover}$	ExtDam(:,11:14)	Exterior damage of Wall Cover. (%)

$ED_{WallSheath}$	ExtDam(:,15:18)	Exterior damage of Wall sheathing. (%)
EffectiveWallArea	AreaEffWallStory	wall area per floor and side- openings area ()
$f\log law(stories)$	fLogLaw	wind profile reduction to translate reference wind speed height to model height
fPerc	Fperc	percolation from story to story. (%)
HR_1	IR1	Horizontal rain integrated from time of occurrence of start of storm to time of max wind speed (inches)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
RAF_*Breach(floor)*	RAF_*Breach*	Contribution of direct impinging rain acting on a wall component including storm rotation after breach
RAF_*Defects(floor)*	RAF_*Defect*	Contribution of direct impinging rain acting on a wall component including storm rotation prior to breach
$\overline{RAF}_{\theta j}$(story)	RAF_wall_short/long	Mean Rain Admittance Factor on wall surface at story (story) and wind direction θ.
SRC_*Breach(floor)*	SRC_*Breach*	Contribution of surface runoff rain acting on a wall component including storm rotation after breach
SRC_*Defects(floor)*	SRC_*Defects*	Contribution of surface runoff rain acting on a wall component including storm rotation prior to breach
$\overline{SRC}_{\theta j}$	SRC_wall_short/long	Mean Surface Runoff Coefficient on wall surface at story (story) and wind direction θ.
SR_*Breach*	SR_*Breach*	Contribution of Surface runoff Rain on breach
wat(stories)	wat	Total height of water from damage source on a given story floor.
WatIngrBrN_SR(floor)	*WatIngrBrN_SR*	water ingress from surface runoff through envelop breaches evaluated at each floor
WatIngrBrN_DI(floor)	*WatIngrBrN_DI*	water ingress from direct impinging through envelop breaches evaluated at each floor

WatIngrDfN_SR(floor)	*WatIngrDfN_SR*	water ingress from surface runoff through envelop defects evaluated at each floor
WatIngrDfN_DI(floor)	*WatIngrDfN_DI*	water ingress from direct impinging through envelop defects evaluated at each floor
6) Water intrusion through breached wall sheathing File: IntExt_calc_CL_V60		
$Area_{Total}$	AreaBase	total living area (ft^2)
$A_{SR\theta}$	A0,A45,A90	Reference surface runoff area that facilitates runoff for exposed breaches at wind angle θ (ft^2)
BreachArea		breach area on effective wall surface at a modeled story and wall id
β_j	beta(j)	portion of HR_2 that falls in octant *j* during storm rotation
EffectiveWallArea	AreaEffWall	wall area per floor and side - openings area
$ED_{WallCover}$	ExtDam(:,15:18)	Exterior damage of Wall Cover. (%)
$f\log law(stories)$	fLogLaw	wind profile reduction to translate reference wind speed height to model height
fPerc	fPerc	percolation from story to story. (%)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
$\overline{RAF}_{\theta j}$	RAF_Wall_short/long	Mean Rain Admittance Factor on wall surface at story (story) and wind direction θ.
RAF_*Breach(floor)*	RAF_*Breach*	Contribution of direct impinging rain acting on a wall component including storm rotation after breach
SRC_*Breach(floor)*	SRC_*Breach*	Contribution of surface runoff rain acting on a wall component including storm rotation after breach
$\overline{SRC}_{\theta j}$	SRC_Wall_short/long	Mean Surface Runoff Coefficient on wall surface at story (story) and wind direction θ
wat	Wat	Total height of water from damage source on a given story floor.
7) Water intrusion through windows File: IntExt_calc_CL_V60		
$Area_{Defects}$	WatAreaDefect	Area of exposed defects existing windows (ft^2)
$Area_{Breach}$	WatAreaBreach	Total breached Area of exposed windows (ft^2)
$Area_{Total}$	AreaBase	total living area (ft^2)
$A_{SR\theta\_BrN}$	A0,A45,A90	Reference surface runoff area that facilitates runoff for exposed breaches at wind angle θ (ft^2)
$A_{SR\theta\_DfN}$	A0,A45,A90	Reference surface runoff area that facilitates

		runoff for exposed defects at wind angle θ (ft^2)
α_i	alpha(i)	portion of HR_1 that falls in octant *i* during storm rotation
β_j	beta(j)	portion of HR_2 that falls in octant *j* during storm rotation
$Defects_{window}$	Defwindw	Density of defects in windows
$NumD_{WindowPressure}$	{fp sp tp}	Number of failed windows due to pressure
$NumD_{WindowDebris}$	{fd sd td}	Number of failed windows due to debris impact
ED_{Window}	{f,s,t}	Percentage of windows damaged per wall. (%)
$f\log law(stories)$	fLogLaw	wind profile reduction to translate reference wind speed height to model height
fPerc	fPerc	percolation from story to story.
HR_1	IR1	Horizontal rain integrated from time of occurrence of start of storm to time of max wind speed (inches)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
$\overline{RAF}_{\theta j}$(story):	RAF_Windows	Mean Rain Admittance Factor on wall surface at story (story) and wind direction θ.
RAF_*Breach(floor)*	RAF_*Breach*	Contribution of direct impinging rain acting on a wall component including storm rotation after breach
RAF_*Defects(floor)*	RAF_*Defects*	Contribution of direct impinging rain acting on a wall component including storm rotation prior to breach
$\overline{SRC}_{\theta j}$	SRC_Windows	Mean Surface Runoff Coefficient on wall surface at story (story) and wind direction θ.
SRC_*Breach(floor)*	SRC_*Breach*	Contribution of surface runoff rain acting on a wall component including storm rotation after breach
SRC_*Defects(floor)*	SRC_*Defects*	Contribution of surface runoff rain acting on a wall component including storm rotation prior to breach
wat	Wat	Total height of water from damage source on a given story floor.
WatIngrBrN_SR(floor)	*WatIngrBrN_SR*	water ingress from surface runoff through window breaches evaluated at each floor
WatIngrBrN_DI(floor)	*WatIngrBrN_DI*	water ingress from direct impinging through window breaches evaluated at each floor
WatIngrDfN_SR(floor)	*WatIngrDfN_SR*	water ingress from surface runoff through window defects evaluated at each floor
WatIngrDfN_DI(floor)	*WatIngrDfN_DI*	water ingress from direct impinging through window defects evaluated at each floor

8) Water intrusion through Doors File: IntExt_calc_CL_V60		
$Area_{Defects}$	Defect_area	Area of exposed defects in existing Doors (ft^2)
$Area_{Breach}$	Breach_area	Total breached Area of exposed Doors (ft^2)
$Area_{Total}$	AreaBase	total living area (ft^2)
$A_{SR\theta\_BrN}$	A_SRC_BrN	Reference surface runoff area that facilitates runoff for exposed breaches at wind angle θ (ft^2)
$A_{SR\theta\_DfN}$	A_SRC_DfN	Reference surface runoff area that facilitates runoff for exposed defects at wind angle θ (ft^2)
α_i	alpha(i)	portion of HR_1 that falls in octant *i* during storm rotation
β_j	beta	portion of HR_2 that falls in octant *j* during storm rotation
$Defects_{Door}$	DefDoor	Density of defects in exterior door
ED_{Doors}	({f,s,t})	Percentage of doors damaged per wall. (%)
$f\log law(stories)$	fLogLaw	wind profile reduction to translate reference wind speed height to model height
fPerc	fPerc	percolation from story to story. (%)
HR_1	IR1	Horizontal rain integrated from time of occurrence of start of storm to time of max wind speed (inches)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
$NumD_{DoorsPressure}$	{fw,sw,tw}	Number of failed doors due to pressure
$NumD_{DoorsDebris}$	{fd,sd,td}	Number of failed doors due to debris impact
RAF_*Breach(floor)*	RAF_*Breach*	Contribution of direct impinging rain acting on a doors including storm rotation after breach
RAF_*Defects(floor)*	RAF_*Defects*	Contribution of direct impinging rain acting on a doors including storm rotation prior to breach
$\overline{RAF}_{\theta j}$ (story)	RAF_doors	Mean Rain Admittance Factor on doors at story (story) and wind direction θ.
$\overline{SRC}_{\theta j}$	SRC_doors	Mean Surface Runoff Coefficient on doors at story (story) and wind direction θ.
SRC_*Breach(floor)*	SRC_*Breach*	Contribution of surface runoff rain acting on a doors including

		storm rotation after breach
SRC_*Defects(floor)*	SRC_*Defects*	Contribution of surface runoff rain acting on doors including storm rotation prior to breach
SR_*Breach*	SR_*Breach*	Contribution of Surface runoff Rain on breach
wat(stories)	wat	Total height of water from damage source on a given story floor
WatIngrBrN_SR(floor)	*WatIngrBrN_SR*	water ingress from surface runoff through door breaches evaluated at each floor
WatIngrBrN_DI(floor)	*WatIngrBrN_DI*	water ingress from direct impinging through door breaches evaluated at each floor
WatIngrDfN_SR(floor)	*WatIngrDfN_SR*	water ingress from surface runoff through door defects evaluated at each floor
WatIngrDfN_DI(floor)	*WatIngrDfN_DI*	water ingress from direct impinging through door defects evaluated at each floor
9) Water intrusion through Sliders File: IntExt_calc_CL_V60		
$Area_{Defects}$	Defect_area	Area of exposed defects in existing Sliders (ft^2)
$Area_{Breach}$	Breach_area	Total breached Area of exposed Sliders (ft^2)
$Area_{Total}$	AreaBase	total living area (ft^2)
$A_{SR\theta\_BrN}$	A_SRC_BrN	Reference surface runoff area that facilitates runoff for exposed breaches at wind angle θ (ft^2)
$A_{SR\theta\_DfN}$	A_SRC_DfN	Reference surface runoff area that facilitates runoff for exposed defects at wind angle θ (ft^2)
α_i	alpha(i)	portion of HR_1 that falls in octant *i* during storm rotation
β_j	beta	portion of HR_2 that falls in octant *j* during storm rotation
$Defects_{Slider}$	DefSlider	Density of defects in exterior slider
$ED_{Sliders}$	{f,s,t}	Percentage of sliders damaged per wall. (%)
$f\log law(stories)$	fLogLaw	wind profile reduction to translate reference wind speed height to model height
fPerc	fPerc	percolation from story to story. (%)
HR_1	IR1	Horizontal rain integrated from time of occurrence of start of storm to time of max wind speed (inches)

HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
$NumD_{SlidersPressure}$	{fw,sw,tw}	Number of failed sliders due to pressure
$NumD_{SlidersDebris}$	{fd,sd,td}	Number of failed sliders due to debris impact
RAF_*Breach(floor)*	RAF_*Breach*	Contribution of direct impinging rain acting on a sliders including storm rotation after breach
RAF_*Defects(floor)*	RAF_*Defects*	Contribution of direct impinging rain acting on a sliders including storm rotation prior to breach
$\overline{RAF}_{\theta j}$ (story)	RAF_sliders	Mean Rain Admittance Factor on sliders at story (story) and wind direction θ.
$\overline{SRC}_{\theta j}$	SRC_sliders	Mean Surface Runoff Coefficient on sliders at story (story) and wind direction θ.
SRC_*Breach(floor)*	SRC_*Breach*	Contribution of surface runoff rain acting on a sliders including storm rotation after breach
SRC_*Defects(floor)*	SRC_*Defects*	Contribution of surface runoff rain acting on sliders including storm rotation prior to breach
SR_*Breach*	SR_*Breach*	Contribution of Surface runoff Rain on breach
wat(stories)	wat	Total height of water from damage source on a given story floor.
WatIngrBrN_SR(floor)	*WatIngrBrN_SR*	water ingress from surface runoff through slider breaches evaluated at each floor
WatIngrBrN_DI(floor)	*WatIngrBrN_DI*	water ingress from direct impinging through slider breaches evaluated at each floor
WatIngrDfN_SR(floor)	*WatIngrDfN_SR*	water ingress from surface runoff through slider defects evaluated at each floor
WatIngrDfN_DI(floor)	*WatIngrDfN_DI*	water ingress from direct impinging through slider defects evaluated at each floor
10) Water intrusion through Soffits File: IntExt_calc_CL_V60		
$Area_{soffit}$	AreaSoffit	Area of soffit susceptible to water intrusion (ft^2)
$Area_{Total}$	AreaBase	total living area (ft^2)
α_i	alpha(i)	portion of HR_1 that falls in octant *i* during storm rotation
β_j	beta(j)	portion of HR_2 that falls in octant *j* during storm rotation

ED_{soff}	ExtDam	Percentage of soffit material damaged per wall.(%)
$ED_{edgesheathing*}$	Edge_sheathing	Percentage of overhang edge roof sheathing damaged. (%) * Term added to the alternative soffit model for V6.1
$f\log law(stories)$	fLogLaw	wind profile reduction to translate reference wind speed height to model height
fPerc	fPerc	percolation from story to story. (%)
funsoff_defects*	funsoff_defects	heuristic function relating the free stream rain volume to volume ingress from test data (Masters. et.al) * Term modified from funsoff to funsoff_defects for alternative soffit model for V6.1
funsoff_breaches*	funsoffbreaches	heuristic function relating the free stream rain volume to volume ingress through breached soffit material from test data (IBHS) * Term added to the alternative soffit model for V6.1
HR_1	IR1	Horizontal rain integrated from time of occurrence of start of storm to time of max wind speed (inches)
HR_2	IR2	Horizontal rain integrated from time of occurrence of max wind speed to time of end of storm. (inches)
RAF_*Breach(floor)*	RAF_*Breach*	Contribution of direct impinging rain acting on soffit including storm rotation after breach
RAF_*Defects(floor)*	RAF_*Defects*	Contribution of direct impinging rain acting on soffit including storm rotation prior to breach
$\overline{RAF}_{\theta j}$	RAF_soff	Rain Admittance Factor on soffit at wind direction θ.
SoffAlpha	SoffAlpha	factor that relates various soffit materials to heuristic function
wat(stories)	wat	Total height of water from damage source on a given story floor.
WatIngrBrN_DI(floor)	*WatIngrBrN_DI*	water ingress from direct impinging through soffit breaches evaluated on top floor only
WatIngrDfN_DI(floor)	*WatIngrDfN_DI*	water ingress from direct impinging through soffit defects evaluated on top floor only

1.9. Update of the statistics used to weigh the low-rise commercial residential vulnerability matrices (Table 8)

Table 8: Statistics update

Variable Name or Term in Documentation	Variable Name in Code	Description
Weighted Statistics File: Weight_calc_CL080112		
$\mathbf{W}_n$	Wn	Weighted Vulnerability Curves Array for case “n”
$\mathbf{P}_n$	P(:,:,EW)	Conditional Probability of each case of unweighted vulnerability curves being combined. Produces a (6,12,2) array of conditional probabilities, (6 eras, 12 models, 2 exterior wall types)
$\mathbf{Vk}_n$ =	Vk	Vulnerability curves matrix to be combined for case “n”. In this matrix each of its 12 rows has a vulnerability curve (41 elements) to be combined
Exterior wall	EW	Exterior wall type (CB or timber)
Era	ybe	Era of construction
$\mathbf{S}_n$	Sn	Sn= is the selector matrix with 1’s and zeros. $\mathbf{S}_n$ rows select which vulnerability curves of Vkn (rows) will be combined by weights of matrix $\mathbf{P}_n$. $\mathbf{S}_n$ columns say the number of weighted vulnerability curves resulting for each case “n”.
Pop	pop	Pop is a column vector with the probabilities of having/not having shutters for each of the rows of $\mathbf{Vk}_n$

2. Changes in the mid-/high-rise commercial residential model (MHR-CR) of the Engineering Component

2.1. Modeling of an additional volume of water penetration at the upper story (Table 9)

Table 9: Changes to the MHR-CR model

Variable Name or Term in Documentation	Variable Name in Code	Description
# Units	numUnits (PreProcessChecker.cpp)	Number of units in a building
# Stories	numStories (PreProcessChecker.cpp)	Number of stories in a building
$\#Windows^{C}$ $\#Windows^{M}$ #Windows	numWindowsCorner numWindowsMiddle (CRILMHigh.h) numWindows (CRILMHigh.cpp)	Number of windows in a corner (C) or middle (M) unit
a_{C} a_{M}	aC aM (PreProcessChecker.cpp) numberCornerOrMiddleUnits (CRILMHigh.cpp)	Number of corner (C) or middle (M) units per story
a	increment (WindSpeedFile.cpp)	Average wind speed at height range
Avg Apt Area	Not implemented since the # of units per story is set to 10 if the # of units in the building is unknown.	Average apartment area
APV	lmAPP (Risk.h)	Appurtenant Value ($)
AWI(S)	aWITotal->getCell(0, s) (CRILMHigh.cpp)	Average water ingressed for the upper story
AWI(s) AWI(k)	aWITotal->getCell(0, k), aWITotal->getCell(0, s), awi (CRILMHigh.cpp)	Average water ingressed per story (s or k)
$AWI(s)_{C}$ $AWI(k)_{C}$ $AWI(s)_{M}$ $AWI(k)_{M}$	aWICorner.getCell(0, k) aWIMiddle.getCell(0, k) (CRILMHigh.cpp)	Average water ingressed for corner (C) or middle (M) units in a story (s or k)
A_{W} A_{D} A_{S}	AW AD AS (CRILMHigh.cpp)	Size of individual windows (W), doors (D), sliders (S) (sq ft)
alpha	alpha (CRILMHigh.cpp)	Total rainfall before breaches (inches)
α_{MR}	ALPHA (CRILMHigh.h)	Contents coefficient as proportion of Interior Damage
β_{MR}	BETA (CRILMHigh.cpp)	ALE coefficient as proportion of Interior Damage (condo unit policy)
bb	bb (PreProcessChecker.cpp)	Year built cut-off value
B_{W}^{C}	bcCoHDIW,	Breach curve for windows (W), sliders (S),

B_S^C B_D^C	bcCoMDIW, bcCoLDIW bcCoHDIS, bcCoMDIS, bcCoLDIS bcCoHDIE, bcCoMDIE, bcCoLDIE (CRILMHigh.cpp)	and doors (D); for corner (C) units (sq ft as a function of wind speed). They are divided into three groups, one for each of the debris impact zones: high debris impact zone (HDI), medium debris impact zone (MDI), and low debris impact zone (LDI).
$B_W^C(W_O)$ $B_S^C(W_O)$ $B_D^C(W_O)$	bcHDIW.getCell(0, indexOfWind) bcHDIS.getCell(0, indexOfWind) bcHDIE.getCell(0, indexOfWind) (CRILMHigh.cpp)	Breach area for window (W), sliders (S), or door (D) of corner (C) units in a story for a given wind speed
$B_W^C(s)$ $B_S^C(s)$ $B_D^C(s)$	For story i={0,1,2}: bcHDIW, bcHDIS, bcHDIE For story i={3,4,5,6}: bcMDIW, bcMDIS, bcMDIE For story i>6: bcLDIW, bcLDIS, bcLDIE (CRILMHigh.cpp)	Breach curve for window (W), sliders (S), or door (D) for corner units at story s. Based on s, a debris impact zone is adopted.
B_W^M B_S^M B_D^M	bcMiHDIW, bcMiMDIW, bcMiLDIW bcMiHDIS, bcMiMDIS, bcMiLDIS bcMiHDIE, bcMiMDIE, bcMiLDIE (CRILMHigh.cpp)	Breach curve for windows (W), sliders (S), and doors (D); for middle (M) units (sq ft as a function of wind speed). They are divided into three groups, one for each of the debris impact zones: high debris impact zone (HDI), medium debris impact zone (MDI), and low debris impact zone (LDI).
$B_W^M(W_O)$ $B_S^M(W_O)$ $B_D^M(W_O)$	bcHDIW.getCell(0, indexOfWind) bcHDIS.getCell(0, indexOfWind) bcHDIE.getCell(0, indexOfWind) (CRILMHigh.cpp)	Breach area for window (W), sliders (S), or door (D) of middle (M) units in a story for a given wind speed
$B_W^M(s)$ $B_S^M(s)$ $B_D^M(s)$	For story i={0,1,2}: bcHDIW, bcHDIS, bcHDIE For story i={3,4,5,6}: bcMDIW, bcMDIS, bcMDIE For story i>6: bcLDIW, bcLDIS, bcLDIE (CRILMHigh.cpp)	Breach curve for window (W), sliders (S), or door (D) for middle units at story s. Based on s, a debris impact zone is adopted.
beta	beta (CRILMHigh.cpp)	Total rainfall after breaches (inches)
$Breach_T^C(s)$ $Breach_T^M(s)$	breachCorner breachMiddle (CRILMHigh.cpp)	Total breach size of corner (C) and middle (M) units per story (includes defects)
Breach(s, C)	breachAreas	Breach area per story for corner (C) or

Breach(s, M)	(CRILMHigh.cpp)	middle (M) units (sq ft)
$Breach_T$(story)	totalBreach (CRILMHigh.cpp)	Breach area per story (includes defects) (sq ft)
BV	lmS (Risk.h)	Building value ($)
BV_{AB}	vl (Risk.h)	Apartment Building Value ($)
BV_{CB}	vl (Risk.h)	Condominium Building Value ($)
$C_{W\text{-}IR}$	RC_W_IRG (CRILMHigh.h)	Unit replacement cost for impact-resistant windows
$C_{W\text{-}Standard}$	RC_W_NSH_NG (CRILMHigh.h)	Unit replacement cost for standard windows
$C_{W\text{-}StandardShutter}$	RC_W_SH_NG (CRILMHigh.h)	Unit replacement cost for standard windows with shutters
$C_{S\text{-}IR}$	RC_S_IRG (CRILMHigh.h)	Unit replacement cost for impact-resistant slider
$C_{S\text{-}Standard}$	RC_S_NSH_NG (CRILMHigh.h)	Unit replacement cost for standard slider
$C_{S\text{-}StandardShutter}$	RC_S_SH_NG (CRILMHigh.h)	Unit replacement cost for standard slider with shutters
$C_{D\text{-}IR}$	RC_E_IRG (CRILMHigh.h)	Unit replacement cost for impact-resistant door
$C_{D\text{-}Standard}$	RC_E_NSH_NG (CRILMHigh.h)	Unit replacement cost for standard door
C_W C_D C_S	rcWindow rcEntry rcSlider (CRILMHigh.cpp)	Unit replacement cost for windows (W), door (D), or Sliders (S).
CC	numWindowsCorner (CRILMHigh.h)	Number of windows in a corner unit of a closed building
CO	numWindowsCorner (CRILMHigh.h)	Number of windows in a corner unit of an open building
CCT	corridorType (PreProcessChecker.cpp)	Closed Corridor Type
CV	lmC (Risk.h)	Contents Value ($)
CDO(s)	cdoStory (CRILMHigh.cpp)	Cost of damage to the openings at story s ($)
cont	count_stories (WindSpeedFile.cpp)	Wind interpolation counter
D	deduc (CRILM.cpp)	Deductible
D^B D^C D^{AP}	r_buildingDeduc r_contentDeduc r_appurtenantDeduc (CRILM.cpp)	Building (B), contents (C), and appurtenant (AP) deductible.
Defects(s, C) Defects(s, M)	defectsAreas (CRILMHigh.cpp)	Defects for corner (C) and middle (M) units per story (sq ft)
$DefectsAll^C$ $DefectsAll^M$	defectsAllCornerOrMiddle (CRILMHigh.cpp)	Area of all the defects for a corner (C) and middle (M) unit
d_W d_D	dW dD	Defects area for windows (W), door (D) and slider (S) (sq ft)

d_S	dS (CRILMHigh.cpp)	
EDV_j^B EDV_j^{AP} EDV_j^C EDV_j^T	r_buildingEDV r_appurtenantEDV r_contentEDV r_aleEDV (CRILM.h)	Expected damage value of risk j – for building (B), appurtenant (AP), contents (C), and ALE (T) ($)
EDV^B EDV^{AP} EDV^C EDV^T	buildingEDV appurtenantEDV contentEDV aleEDV (CRILM.h)	Overall expected damage value – for building (B), appurtenant (AP), contents (C), and ALE (T) ($)
EDV^T	totalEDV (CRILM.h)	Total expected damage value ($)
EIDR	eIDR (CRILMHigh.h)	Expected interior damage ratio for entire building (%)
EIDR(s) EIDR(k)	idrStory (CRILMHigh.cpp)	Expected interior damage ratio per story (s or k) (%)
$EDV(s)_j^B$ $EDV(s)_j^C$	EDV_j^B and EDV_j^C conputed directly.	Expected story damage value of risk j – for building (B) and contents (C) ($)
$EUDV(s)_j^B$ $EUDV(s)_j^C$ $EUDV(s)_j^{ALE}$	r_buildingEDV r_contentEDV r_aleEDV (CRILM.h)	Expected condo unit damage value, at story s - for building (B), contents (C), and ALE ($)
f_{sim}	F_SIM (CRILMHigh.cpp)	Simultaneity factor that accounts for the walls that actually have rain intrusion due to wind angle
f_{run}	F_RUN (CRILMHigh.cpp)	Runoff factor that accounts for the runoff water on the facades
i	currentCompany (CRILMHigh.h)	Policy counter / other counter
j	currentRisk (CRILMHigh.h)	Risk counter
K_I	ki (CRILMHigh.cpp)	Ratio of interior value to total value
K_I^{AB} K_I^{CB}	kIAB kICB (CRILMHigh.h)	Ratio of interior value to total value for apartment buildings and condominium buildings
LM_B	lmS (Risk.h)	Building policy limit
LM_C	lmC (Risk.h)	Contents policy limit
LM_{ALE}	lmALE (Risk.h)	Additional living expenses policy limit
LM_{AP}	lmAPP (Risk.h)	Appurtenant policy limit
MC	numWindowsMiddle (CRILMHigh.h)	Number of windows in a middle unit of a closed building
MO	numWindowsMiddle (CRILMHigh.h)	Number of windows in a middle unit of an open building
OCT	corridorType	Open corridor type

	(PreProcessChecker.cpp)	
r_i(story, [1,2]), r(s, 1), r(s, 2)	ir1 ir2 (CRILMHigh.cpp)	Impinging accumulated rainfall (inches) per story for i = 1 (time $t_{initial}$ to t_{breach}) and i = 2 (t_{breach} to t_{end})
RAF	RAF, RAF_LAST_STORY, rainAdmittFactor (CRILMHigh.cpp)	Rain admittance factor
ρ	PERCOLATION_FACTOR (CRILMHigh.cpp)	Percolation factor
ρ_S	ROOF_LEAK_FACTOR (CRILMHigh.cpp)	Roof leak factor
s	s (CRILMHigh.cpp)	Story number
S	s (CRILMHigh.cpp)	Total number of stories/upper story in building
S_W^C S_S^C S_D^C	Computed "on the fly": numWindows - (bcHDIW.getCell(0, i) / AW numWindows - (bcMDIW.getCell(0, i) / AW numWindows - (bcLDIW.getCell(0, i) / AW 1.0 - (bcHDIS.getCell(0, i) / AS 1.0 - (bcMDIS.getCell(0, i) / AS 1.0 - (bcLDIS.getCell(0, i) / AS 1.0 - (bcHDIE.getCell(0, i) / AD 1.0 - (bcMDIE.getCell(0, i) / AD 1.0 - (bcLDIE.getCell(0, i) / AD (CRILMHigh.cpp)	Survival function for windows (W), door (D), and sliders (S) in a corner (C) unit. Divided into the three debris impact zones: high debris impact zone (HDI), medium debris impact zone (MDI), and low debris impact zone (LDI).
S_W^M S_S^M S_D^M	Computed "on the fly": numWindows - (bcHDIW.getCell(0, i) / AW numWindows - (bcMDIW.getCell(0, i) / AW numWindows - (bcLDIW.getCell(0, i) / AW 1.0 - (bcHDIS.getCell(0, i) / AS 1.0 - (bcMDIS.getCell(0, i) / AS 1.0 - (bcLDIS.getCell(0, i) / AS 1.0 - (bcHDIE.getCell(0, i) / AD 1.0 - (bcMDIE.getCell(0, i) / AD 1.0 - (bcLDIE.getCell(0, i) / AD (CRILMHigh.cpp)	Survival function for windows (W), door (D), and sliders (S) in a middle (M) unit. Divided into the three debris impact zones: high debris impact zone (HDI), medium debris impact zone (MDI), and low debris impact zone (LDI).
T_{ID}	TID (CRILMHigh.cpp)	Water level threshold (inches) to complete interior damage
TECDO	tECDO (CRILMHigh.cpp)	Total expected cost of external damage to openings
Area, Total Building	buildingArea (CRILMHigh.cpp)	Total building area

Area		
TV	ImALE (Risk.h)	Time element coverage value ($)
U_S	uS (PreProcessChecker.cpp)	Units per story
UBV	ImS (Risk.h)	Condo unit value (structure)
UCV	ImC (Risk.h)	Condo unit value (contents)
UALE	ImALE (Risk.h)	Condo unit value (additional living expenses)
$UnitArea_C$	unitAreaC (CRILMHigh.h)	Area of a corner unit (sq ft)
$UnitArea_M$	unitAreaM (CRILMHigh.h)	Area of a middle unit (sq ft)
V_W^C V_D^C V_S^C	vcCoHDIW vcCoMDIW vcCoLDIW vcCoHDIE vcCoMDIE vcCoLDIE vcCoHDIS vcCoMDIS vcCoLDIS (CRILMHigh.cpp)	Vulnerability curve for openings of corner units for window (W), door (D), and sliders (S). Give the number or fraction of opening damaged as a function of wind speed. Divided into three debris impact zones: high debris impact zone (HDI), middle debris impact zone (MDI), and low debris impact zone (LDI).
$V_W^C(s, w(z_S))$ $V_D^C(s, w(z_S))$ $V_S^C(s, w(z_S))$	For i={0,1,2}: vcHDI For i={3,4,5,6}: vcMDI For i>6: vcLDI (CRILMHigh.cpp)	Vulnerability for window (W), door (D), or sliders (S) of corner units as a function of wind speed at story height s. Depending on s, a debris impact zone is adopted.
V_W^M V_D^M V_S^M	vcMiHDIW vcMiMDIW vcMiLDIW vcMiHDIE vcMiMDIE vcMiLDIE vcMiHDIS vcMiMDIS vcMiLDIS (CRILMHigh.cpp)	Vulnerability curve for openings of middle units for window (W), door (D), and sliders (S). Divided into three debris impact zones: high debris impact zone (HDI), middle debris impact zone (MDI), and low debris impact zone (LDI).
$V_W^M(s, w(z_S))$ $V_D^M(s, w(z_S))$ $V_S^M(s, w(z_S))$	For i={0,1,2}: vcHDI For i={3,4,5,6}: vcMDI	Vulnerability for window (W), door (D), or sliders (S) of middle units as a function of wind speed at story height s. Depending on s, a debris impact zone is adopted.

	For i>6: vcLDI (CRILMHigh.cpp)	
$w(z_S)$	indexOfWind (CRILMHigh.cpp)	Wind speed at height z_S
W_O	windProfile (CRILMHigh.cpp)	Wind speed vector/Wind speed profile
$W_O(s)$	currentWind (CRILMHigh.cpp)	Wind speed profile at story s
$W_O(s=3)$	vP_10m (CRILMHigh.cpp)	Wind speed profile at third story (at 10 meters)
w_0 w_1	windLow windHigh (WindSpeedFile.cpp)	Wind speed at index i and i+1, respectively, of wind vector
W_i	m2 (WindSpeedFile.cpp)	Wind speed vector containing the wind speed at all possible stories that a building may have
W_S	storyInterpWinds (WindSpeedFile.h)	Wind speed vector containing the wind speed at each story of the building
z_S	i (CRILMHigh.cpp)	Mean height of story s. For s = 3, z_S is assumed to be 10m

Changes to FPHLM V6.0 to become FPHLM V6.1

1. Changes in the low-rise commercial residential model of the Engineering Component

1.1. Modeling of the gable end damage for masonry models (Table 10)

Table 10: Masonry wall damage calculation

Variable Name or Term in Documentation	Variable Name in Code	Description
Masonry wall damage calculation routine File: Masonry_Shear_Wall_Failure.m		
Load on sheathing the Gable End	Load_GableEndSheets_ShortSide1	Load determined using the factor ASCE 7-05 pressure coefficients for sheathing
Pressure coefficient on gable end	GCpFinalGableEndShortSide1	ASCE 7-05 pressure coefficient combined with interior pressure
Wind speed at gable end	WindSpeeds_GableEnd_Walls	The log profile calculated wind speed at the gable end mid height
Map of gable end sheathing	GableEndSheetMapShortSide13D	Matrix of sheathing location on the gable end
Capacity of gable end sheathing	GableEndWallSheetsShortSide1SheetCapacity3D	Matrix of the randomized capacities for each gable end panel
Load/Capacity resultant	G_GableEndWallsShortSide1	Matrix of the summation of load vs capacity
Map of damage gable end sheathing	MapofDamagedSheets_GableEndWallsShortSide1	Matrix identifying damaged and undamaged panels
Load on wall cover the Gable End	Load_GableEndWallCover_ShortSide1	Load determined using the factor ASCE 7-05 pressure coefficients for wall cover
External pressure coefficient on gable end	GCpExternalFinalGableEndShortSide1	ASCE 7-05 pressure coefficient combined with interior pressure
Map of gable end wall cover	GableEndWallCoverMapShortSide13D	Matrix of wall cover locations on the gable end
Capacity of gable end wall cover	GableEndWallCoverShortSide1SheetCapacity3D	Matrix of the randomized capacities for each gable end wall cover
Map of damage gable end wall cover	MapofDamagedWallCover_GableEndWallsShortSide1	Matrix identifying damaged and undamaged panels

1.2. Further modification of the masonry wall area failure function and its differentiation between unreinforced and reinforced masonry (Table Table 6)

No additional variables where necessary for this change.

1.3. Correction to the dimension of gable end upstream run-off area ASR in the rain penetration model (Table 7, section 4)

No additional variables where necessary for this change.

1.4. Introduction of an alternative soffit model

See Table 7, section 10, description where asterisks indicate the variables linked to the change to v6.1.