



Seismic Resilience and Risk Assessment of the Yield-Link® Connection for Steel Construction Webinar Q&A

This document includes questions submitted by attendees during the live webinar, *Seismic Resilience and Risk Assessment of the Yield-Link® Connection for Steel Construction*, held on May 2, 2019, along with presenter responses. In some cases, duplicate questions have been combined and noted as such. Please send any additional technical questions to AskSimpson@strongtie.com.

Question	Answer
Yield-Link Connection	
1 What special details are required with Yield-Link for metal deck and concrete slabs connected to top flange?	Simpson has prepared and can provide standard details to accommodate the slab over the connection. Please contact Simpson Strong-Tie (SST).
2 Can you please comment on the stability of a MRF that uses yield link that is subjected to a rare earthquake event - which causes the yield link to fracture, it appears that that the connection no longer has moment capacity once it has failed? Note in New Zealand we have observed 2x or greater seismic load in recent earthquakes compared to Design Level earthquake	The U.S. code requirements for Risk Category II buildings are for life safety at the DBE (475 yr event) and collapse prevention building performance objective at the MCE (2475 yr event). In the rare event that a link were to fracture, there is still moment resistance through the shear tab connection and the non-fractured link. Also, from our FEMA P695 study, that did NOT consider any residual moment capacity, we still demonstrated that we had better Collapse Margin Ratios as compared to Reduced Beam Section (RBS) archetypes.
3 When using yield link connection, does the SMF need to be simpson's or any other column-beam sizes meeting SMF requirements can be used? Who designs the yield links? How do we spec this out, detail or indicate in design drawings?	We sell the link kits directly to the fabricator/erector. The beams and columns are called out by the specifying engineer as with any other SMF. The design procedure for the Yield-Link is provided in AISC 358-16 Chapter 12. We have plug-ins for SAP/Etabs and spreadsheets that can be imported into RAM and Risa; we will be integrated to these two programs early next year. There are also Revit and Tekla plug-ins available on our website. All of these plug-ins are free of charge to download.
4 Is the yield link connection part of the protected zone?	The protected zone follows the bolted area of the links and 1-1/2" out from the shear tab web connection. There is no protected zone in the web between the link connections.
5 How are the metal deck and slab dimensional issues accounted for during construction	Simpson has prepared and can provide standard details to accommodate the slab over the connection. Please contact SST.
6 How does the connection of the floor to the beam at the yield link is located, addressed in the detail/design drawings?	Simpson has prepared and can provide standard details to accommodate the slab over the connection. Please contact SST.

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| 7 | How can the yield link connection be configured when the top of column is flush with the top of the beam? | The bolted style connection means there will be a height difference between top of beam to top of column. Depending on the floor assembly, the finish may be detailed to accommodate the difference. Please contact SST. |
| 8 | Is it easy to replace the top flange yield link if the composite deck is attached to the moment frame beam?

<i>(Similar)</i>
How is the Yield-Link replaced? What would the process be?

<i>(Similar)</i>
How easy is it to replace the yield link fuse in a composite deck? | The local top of concrete would need to be removed to access the Yield-Link. Simpson has prepared and can provide standard details to accommodate removing the slab over the connection. Please contact SST. |
| 9 | Is there a maximum moment demand that yielding link is applicable to? In another word, has the testing been done up to very large moment demand? | The Simpson Strong-Tie steel special moment frame Yield-Link is recognized in International Code Council Evaluation Service Report 2802 (ICC-ES ESR-2802) and it limits the beam depth to a maximum of W36 for rolled shapes and built-up members and limit the column depth to W36 for rolled shapes and built-up members. The maximum moment the connection is rated for would be associated with our largest Yield-Links (yield core of 6" x 1") placed on W36 sections. For, say, a W36x210, the centers of the yield cores are separated by 37.7", yielding a nominal yield moment of $(6 \text{ in}^2)(50\text{ksi})(37.7\text{in})=11,310 \text{ kip-in}$. |
| 10 | Can you please give a short overview of foundation requirements for the yield link moment frames | The foundation requirements for steel special moment frames using the Yield-Link connections are the same as for typical steel special moment frames. |
| 11 | How is the cost of this system handled? Who fabricates the connection detail pieces? Is there a licensing fee, etc.? | The Yield-Link connection is supplied to approved structural steel fabricators. The designer would use the structural software (i.e., SAP, ETABS, etc.) plug-ins to determine the appropriate design for a special moment frame with Yield-Links for a given project, the designer would specify those in the construction documents, the structural steel fabricator would develop shop drawings for the designer to review, Simpson Strong-Tie would provide the Yield-Link connections to the fabricator, and then the fabricator would provide the special moment frame members and Yield-Link connections to the contractor. |
| 12 | I may have missed it in the webinar but is there an estimate to how much the construction costs are increased with the use of the yield-links? | We have seen the costs to be similar, and in some cases less expensive, as the beams may be designed without lateral bracing and field welding is not required. |

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| 13 | Is there a link to download technical specifications sheets for Yield-Link? | See https://www.strongtie.com/solutions/mid-rise-steel/yield-link |
| 14 | What is the best way to estimate story drifts using yield links? | Story drift analysis must be performed with a model that includes the rotational stiffness of the connection. |
| 15 | Is yielding link stiffer or softer than RBS when the yielding moments are the same? | Comparing a Yield-Link/beam combination with a given plastic section modulus (yield moment) to a W section with the same plastic section modulus, the corresponding moment of inertia (stiffness) of the Yield-Link connection will be greater than the W section moment of inertia. |
| 16 | Can Yield-Link Connection for Steel be stacked for multi-story construction? | The Yield-Link connections may be used in multi-bay and multi-story applications. See AISC 358 and https://www.strongtie.com/solutions/mid-rise-steel/yield-link |
| 17 | Can Yield-Link replace steel jacketing reinforcement for concrete frame structures? Especially at plastic hinge spaces? | We have not yet investigated this use of our Yield-Link connection technology. |
| 18 | What are your thoughts about using the yield link connections for RC steel coupling beams? | We have not yet investigated this use of our Yield-Link connection technology. |
| 19 | In a few of the photos with actual buildings using the yield-link frames they were connected to regular steel frames around the structure. Are there any concerns with the flexibility/drift of the yield-link frames to the regular steel frames interaction? | Steel special moment frames using the Yield-Link connection design provisions are listed in code referenced AISC 358 and may be used in structural steel buildings. Contact Simpson Strong-Tie for assistance with specific applications. |

SP3 Software, Seismic Resilience

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| 19 | Akin to the increase in construction cost, is there a sense of how much additional cost the increase in design work involves? | There is a wide range of effort possible, and it is up to the engineer and owner as to what is desired. With a very minimal level of effort (a few hours), the SP3-RiskModel could be used to make simple up-front design decisions to make the building more resilient (e.g. system selection, decision if design for lower drift limit, etc.). For a more comprehensive resilient design, the SP3-Design platform can be used to get down to the level of detail of non-structural component design (e.g. for ensuring that an essential facility will remain functional after the earthquake). |
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| 20 | Is there a similar application for bridge/overpass structures? | Not specifically, but FEMA P-58 and SP3-Design could be used for this purpose if the user is willing to do their own bridge modeling and create bridge component fragility functions. |
| 21 | Is the statistically-calibrated predictive equation included in the fee for the SP3 subscription or an add-on? | The SP3 Structural Response Prediction Engine is included as part of the SP3-RiskModel and is currently being added into SP3-Design. |
| 22 | Have you seen a willingness of the insurance industry to offer premium reductions in recognition to projects that were designed to limit damage? | This is not yet widespread, but seems to be starting. We had our first insurer start to use SP3 in 2018 for underwriting of high value properties. |
| 23 | How much does the SP3 subscription cost? is it per project basis?

<i>(Similar)</i>
How much for SP3 Design/Risk Model? | Annual licenses are for SP3-Design are \$6,000 and \$8,500. These included one network seat, unlimited user accounts in the company, and 5 and 12 buildings per year, respectively. The SP3-RiskModel licenses are similar per-project, but SP3-RiskModel clients typically purchase higher volumes of projects. |
| 24 | Do these comparison charts between RBS and Yield Link use the same column and beam section sizes? | No. The comparisons are based on complete structural designs using both design approaches. This results in the Yield-Link frames having larger columns, based on the design methods used when designing those frames. |
| 25 | Why are there no nodes in ALL the frame illustration? (Slide 36) | These are just graphical illustrations. All of the nonlinear frame modeling that we do inside of the SP3 Structural Responses Database all include finite joint sizes and nodes that connect joints to columns and beams. |
| 31 | Do you know if a similar effort has been applied to high-wind risk in hurricane regions? | Unfortunately not, but that is a great idea. FEMA spent \$16M on this project to develop this great seismic risk assessment method and I hope they also do the same thing for wind! |
| 32 | How sure are we that the SP3 results are accurate? How are the program results validated/confirmed? | All risk assessments are estimates, since earthquakes and their results have a lot of uncertainty. Given this reality, FEMA P-58 provided the most documented and well-reasoned risk assessment method currently available (built up from a lot of experimental test data and research). For validation, broad comparisons have been done against past generic judgement/experience-based methods (e.g. Hazus) and their comparisons have shown that the answers agree well on average, but show that P-58 results vary by ~x2 for individual buildings because P-58 is building-specific and Hazus is not building-specific (it is for broad categories of buildings only). |

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| 33 | Do you provide training on how to use the SP3 program? If so, is this part of the cost of the program or an add-on? For tech help, do you have engineers on board providing assistance? | Training is included in the license costs and is important part of what we do in supporting SP3. We have a staff of licensed engineers that do both the trainings and the technical support. |
| 34 | Have the repair costs versus drift in P-58 been compared to the rebuilding effort in Christchurch, New Zealand? | Yes; comparisons have been done through recent PhD research out of Stanford. This included Christchurch information and also instrumented buildings in CA in past earthquakes. |
| 35 | Question for SP3: When structural responses are input from, say response spectrum response or using the built-in SP3, how is the variability of structural responses included in the probabilistic analysis? In another word, with only 1 set of response data is input, how is Monte Carlo conducted? | The variability in responses is included through variability in responses and through a detailed correlation model create in SP3 that correlates the various responses appropriately as the Monte Carlo similar is run. In short, variability is fully included even if the provided responses are only mean values. |

Miscellaneous

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| 36 | How can I get the handouts? | <p>Here are links to the resources we shared:</p> <ul style="list-style-type: none"> • Example SP3 Report: Yield-Link • FEMA P-58: Seismic Performance Assessment of Buildings • NIST Community Resilience Planning Guide • Resilient Design Flyer • White Paper: Resilient Design of New Buildings • White Paper: Expected Seismic Performance of New Buildings in California • Presentation slides |
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| 37 | Can you also send the poll question results to the webinar attendees? | <p>In general, what do you think the estimated percent increase in cost is for a resilient based designed Risk Category II building compared to code minimum designed minimum?</p> <table border="0"> <tr> <td><input type="radio"/> Up to 50% of the total construction cost</td> <td style="text-align: right;">3.57%</td> </tr> <tr> <td><input type="radio"/> Up to 25% of the total construction cost</td> <td style="text-align: right;">32.94%</td> </tr> <tr> <td><input type="radio"/> Up to 12% of the total construction cost</td> <td style="text-align: right;">41.67%</td> </tr> <tr> <td><input type="radio"/> Up to 3% of the total construction cost</td> <td style="text-align: right;">21.83%</td> </tr> </table> | <input type="radio"/> Up to 50% of the total construction cost | 3.57% | <input type="radio"/> Up to 25% of the total construction cost | 32.94% | <input type="radio"/> Up to 12% of the total construction cost | 41.67% | <input type="radio"/> Up to 3% of the total construction cost | 21.83% |
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How familiar are you with FEMA P-58 Seismic Performance Assessment of Buildings?

