Proper Selection, Specification and Seismic Details of Open-Web Steel Joist framing for Roofs in California

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Abstract

Considerable variability in how open-web steel joists and joist girders are selected and specified is a current and easily avoided problem. Furthermore, seismic load transfer details chosen by engineers are often inconsistent with the type of joist or girder specified. This paper will attempt to outline clear guidelines for selecting and specifying economical joists with appropriate details for seismic load transfer.

Simple methods to determine the most economical joist and girder depths for their respective spans will be presented to assist the engineer. These rules-of-thumb enable the engineer to pick the most economical framing depths without reviewing a manufacturer's catalog. Minimum depths of a joist or girder for a given span are calculated with a simple equation.

Sloped seats and pitched chords as a means of accommodating changes in roof elevations are examined. The methods of properly designating single-pitched and double-pitched joists and girders for best economy are presented.

Wall anchorage and continuity tie details are explored with an emphasis on matching the details to the bearing seats associated with each specific joist or girder series. The spacing of the continuity ties based on the type of diaphragm (wood/steel) utilized with the joists is discussed. Typical axial transfer details for the exterior and interior bearing lines are reviewed. The orientation of the joist framing may be changed on "larger" buildings to help facilitate the wall anchorage force distribution into the diaphragm.

Industry Challenge and Perspective

Steel joists and joist girders have been used in combination with steel deck throughout the years. Within the last 15 years, the application of steel joists in combination with a panelized wood roof system has also increased in popularity.

Accompanying the increase in popularity of steel joist applications is the number of engineering firms attempting to specify steel joist products. Unfortunately, there are number of design firms without a clear understanding of the roles to be played by the steel joist manufacturer and the design firm itself. Some of this misunderstanding is the result of the design firms following the preferences of a firm other than the joist manufacturer in the presentation of joist and girder design criteria.

The biggest challenge facing the steel joist industry is not the actual manufacture of the steel joist products but obtaining the necessary information from the engineering firm to detail and design the various joist products from the design parameters on the structural drawings.

It is not uncommon for the structural contract drawings to lack the following required information: joist or girder depths, uniform loads on the joists or point loads on the girders, axial loads, net uplift loads, mechanical and screen loads, wall brace loads, etc. It is the role of the joist manufacturer to design the joist and girder products for identified parameters. However, it is the engineer of record's role to provide these parameters in a clear, non-conflicting manner on the roof framing plan or in a joist and girder schedule referenced to the roof framing plan.

Listing dead and live loads in psf with the expectation of the joist manufacturer allocating the loads to the steel joists and girders is not an acceptable practice from the joist manufacturers' viewpoint. These values should be expressed in plf on the joists and kip loads on the girders. Likewise, net uplift must be given rather than gross uplift values or wind speed values.

When a joist manufacturer is contacted after bidding for a delivery schedule, the quality and completeness of the structural drawings are the primary factor influencing the manufacturer's delivery schedule. Drawings with missing, incomplete and conflicting information will result in the manufacturer pushing back the delivery dates.

If the engineering firm has done a "limited" or "poor" presentation of the joist and girder design criteria, the number of manufacturers willing to bid and supply the joist products decreases. "Limited" or "poor" presentation will also result in few, if any, independent detailing firms willing or able to generate approval drawings when the manufacturer's detailing departments are at capacity.

In summary, "limited" or "poor" presentation of the joist and girder design criteria severely restricts the owner's choices with regard to schedule, detailers, and manufacturers. The owner can also expect to pay a premium for the product since the costs and time involved for the manufacturer to bid and then service the project rise considerably with "poor" drawings.

The balance of this paper will give an engineer the essentials of proper selection and specification (designation) of the steel joist and girder products. By following these guidelines, the engineer, manufacturer and owner will see improved economy and delivery of steel joist products.

Minimum Joist Information

All joists on a project should have a designation containing depth (inches), joist type (Series), and a uniform load requirement. The joist Series callout instructs the joist manufacturer to design the joist according to the applicable Steel Joist Institute (SJI) Specification for the Series. The SJI Specifications for each Series covers the design, manufacture and use of the joists within the Series.

K-Series (shortspan) joists range in depth from 8 inches to 30 inches with spans ranging from 8 feet to 60 feet. The maximum uniform load on a K-Series joist is 550 plf, and the maximum end reaction must be less than 9500 lbs.

LH-Series (longspan) joists have a minimum depth of 18 inches and minimum span of 20-0. DLH-Series are merely "deep" longspan joists and have a minimum depth of 52 inches. The same SJI specification governs LH and DLH joists so the "D" in DLH has no significance.

The final designation component to go with the depth and Series is the uniform load requirement. The engineer of record can either pick a standard SJI chord size from the SJI Load Tables to complete the designation or add the total load / live load in plf after the depth and Series.

Examples of joists with the standard SJI chord size whose capacities are found in the SJI Load Tables are 12K3, 20K5, 30K9, 18LH03, 32LH10, and 56DLH13.

Examples of joists with the design total and live load in plf added to the depth and Series are 20K240/128, 32LH310/160 and 52DLH224/96.

If the engineer is intent on using the standard SJI chord size designation, the economical joist guides located in the manufacturer's or SJI's catalog can be utilized to find the most economical standard designation SJI joist. There are some sizeable jumps in the allowable plf loadings in the economical joist guides so caution must be exercised when using these guides.

A better approach, based on 25 plus years of familiarity with roofs in California by the author, is to use the following guidelines to pick the Series of joists. Use total load / live load designations with K-Series for spans less than 48 feet. Use LH-Series joists with total load / live load for spans greater than 48 feet. For 48 feet, use K-Series if the depth sought is less than or equal to 30 inches, otherwise a 32LH joist will work best. The stated guidelines work within the normal dead load range of 12 psf to 18 psf with 20 psf live load (reducible) and joist spacings between 6 feet and 10 feet inclusive.

There will be differences in the joist depths using these two approaches of selection but designating the joist with a depth followed by the Series and followed by the total load and live load in plf has proven to yield the lightest joists which are, in most cases, more economical than heavier joists.

Economical Joist Depth Selection

The selection of the most economical joist depth for a given span with the typical dead load of 12 to 18 psf with a 20 psf reducible live load is simple. The most economical depth, inches is equal to span (ft)/2 + 6 rounded up to the nearest even depth in inches.

Example 1: Chose the most economical depth for a joist spanning 50 feet, carrying a 128 plf live load and 120 plf dead load.

Solution: 50/2 + 6 = 25 +6 = 31, round up to 32 inches. The joist series preferred would be LH since >= 48 feet and the joist designation is 32LH248/128.

Economical Girder Depth Selection

The most economical depth for girders for roof loading in California, inches, is equal to span (ft) + 4, round up to the nearest inch. If this depth cannot be used due to clear height constraints, the engineer is advised to use the maximum depth allowable given the clear height constraint (deeper is cheaper). The seat depths of the joists bearing on the top of the girder must be taken into account when arriving at the girder depth.

The minimum girder depth is 18 inches for most manufacturers with a few manufacturers allowing 16 inch girders. It is quite common to increase the girder depths when the roof height increases, moving towards the ridge. For instance, the first girder line off the exterior wall may have 36 inch deep girders with the next girder lines having 48 inch and 60 inch girders respectively, moving towards the ridge.

For most roof situations, 60 inch girders should be considered an upper bound when considering girders for most typical roof applications. Any increase in depth over 60 inches has marginal benefit since shipping costs and panel configurations for typical joist spacings start to penalize any further depth increase.

Example 2: Chose the most economical depth for a girder spanning 48 feet, carrying a TL/LL of 11.7/5.0K every 8 feet. The number of joist spaces between the column centerlines is the number for N.

Solution: The girder depth, in inches, is span (ft) + 4 which is equal to 48 + 4 = 52 inches. The proper girder designation is 52G6N11.7/5.0K

Example 3: A 50 foot long joist girder has 10.8/4.8K loads occurring at following intervals from the left column: 4 feet, 5 @ 8 feet, with the last space to the other column equal to 6 feet. Select the girder depth and designation for this girder.

Solution: Girder depth = 50 + 4 = 54 inches and the designation is 54G7N10.8/4.8K.

Minimum Joist or Girder Depth

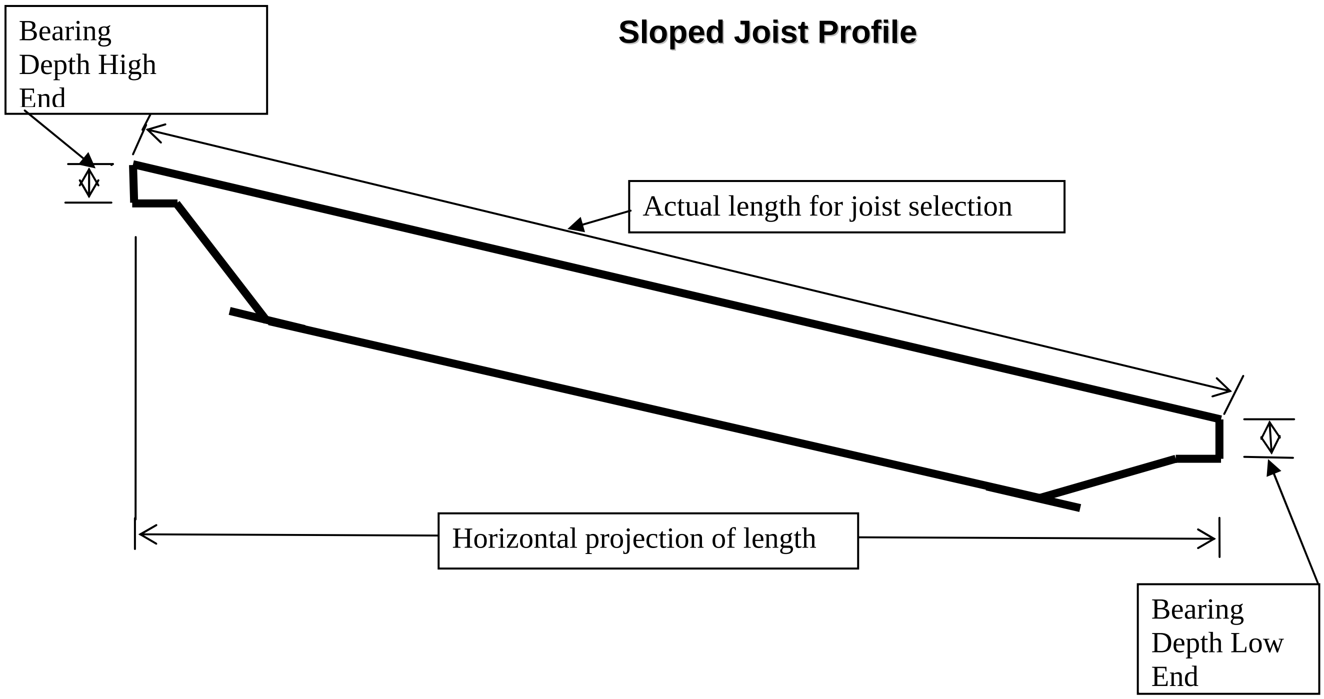
The Steel Joist Institute Specifications limit the span (inches) to depth (inches) ratio to 24 for both joists and girders. Engineers designing buildings are often presented with a span and are asked by the contractor or architect for the minimum depth joist or girder. The engineer needs to simply divide the span in feet by 2 and round up the answer to the nearest even inch.

Serviceability issues such as deflection and ponding issues should be reviewed if the minimum joist or girder depth is used for a given span. The engineer should make a conscious effort to examine his deflection criteria in conjunction with SJI camber when faced with a minimum depth to span situation.

Since the minimum depth is not the most economical depth for the joists or girders, project economy can be expected to be impacted negatively, at least with regard to the joist and girder framing costs. This negative economy may be further compounded if the engineer has specified stringent total and/or live load deflection criteria.

The use of single-pitched or double-pitched joist or girder members may help achieve clear heights without penalizing the framing economy.

Sloped Joist Profile



Accommodating Roof Elevation Changes

The two most common methods of accommodating roof elevation changes along the length of a joist or girder are sloped seats or pitched chords. If all of the elevation changes are accounted in the joist or girder seats only, this condition is called a "sloped seat" condition. If the overall depth of the joist or girder varies along its length, this condition is referred to as a "pitched chord" condition.

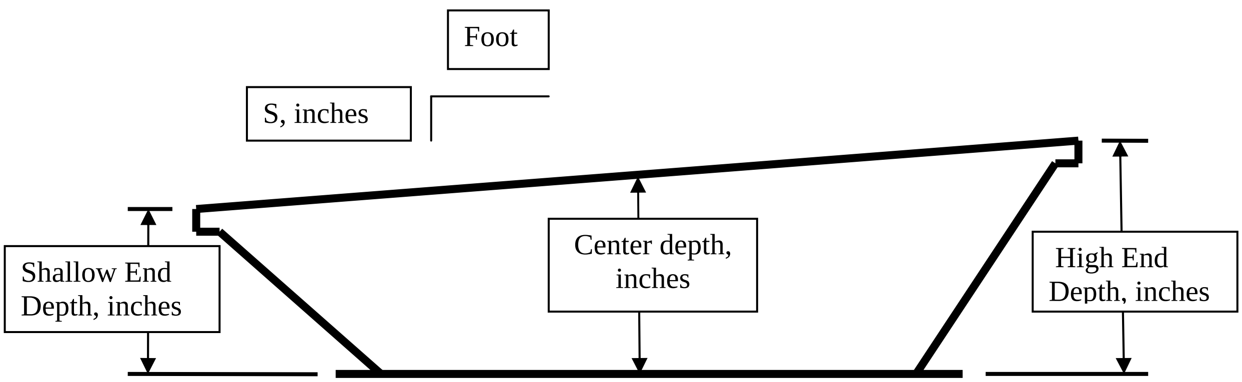
Sloped seats are generally less expensive than pitched chords and can be provided, when required, on all joists and girders. Pitched chords are not available on K-Series joists, primarily due to manufacturing issues such as the impractical bending of continuous rod webs to different heights along the joist. A lightly loaded pitched LH-Series joist can be manufactured in lieu of a pitched K-Series joist.

Sloped seat conditions will require the bearing seat heights to be adjusted on the joist ends and the engineer must reflect the seat height requirements in the structural details. Manufacturers' catalogs have seat depth guidelines for the various slopes, with and without top chord extensions. Sloped seats are provided by the manufacturer when the roof elevation change per length of joist exceeds ¼ inch per foot.

On sloped seat joists or girder, the top and bottom chords remain parallel. The engineer must select the joist for a sloped seat condition by considering the sloped length of the joist and not the plan (horizontal projection) dimension.

There are many different profiles for pitched joists or girders including single-pitched, double-pitched, offset double-pitch, gable and bowstring profiles. The engineer of record must convey the pitch or radius to the manufacturer either by drawing a rough profile, giving both end depths and ridge depth, or noting the ridge depth on the plan with the clear indications of the pitch in one or both directions from the ridge.

A minimum end depth of 18 inches should be initially considered when reviewing the geometry of pitched joists. A manufacturer may be able to reduce the end depth on some joists to 12 inches but the engineer should contact the manufacturer prior to proceeding with this shallower end depth. The manufacturer will need to know the span, loading, and pitch to evaluate a shallower end depth. For joists over 72 feet, the



Single-pitched joist

minimum end depth in inches should be at least L/4 where L is the span in feet.

The minimum centerline depth guidelines cited earlier apply to all joists, pitched or with sloped seats. Again, the minimum depth in inches is equal to the span (ft)/2. A 60 foot joist would require a minimum depth of 30 inches (60/2).

Pitched Joist Selection Guidelines

The most economical depth in inches for a single pitched joist is the same as for a parallel chord joist, namely the centerline depth, inches, is equal to the span (ft)/2 + 6, rounded up to the nearest even inch. A single-pitched joist of 60 feet would have an economical depth of 60/2 + 6 = 36 inches at the center of the span. The low end depth must be 18 inches at a minimum. If this joist had a ½ inch per foot pitch, 144 plf dead load and 128 plf live load, a complete joist designation would be 21-36-51LH272/128 or alternatively 21-51LH272/128.

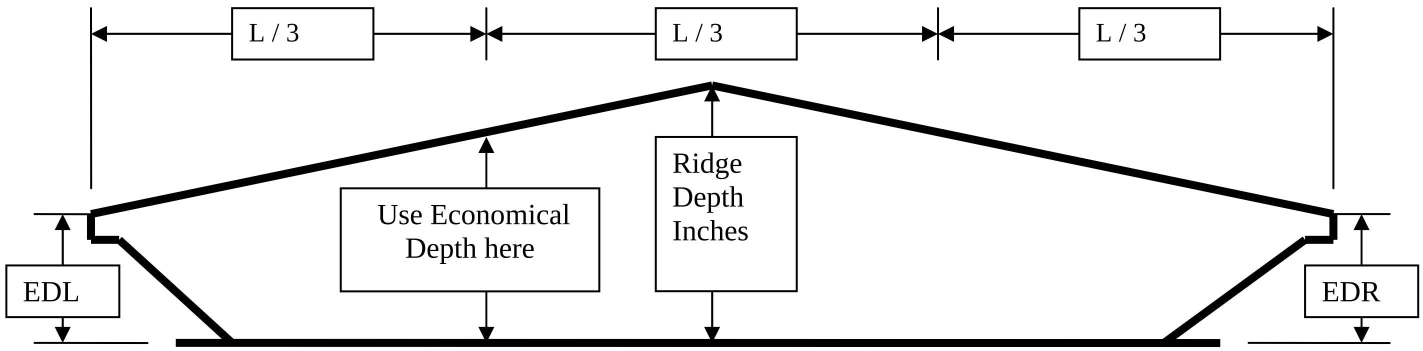
For a double-pitched joist, the depth, in inches, at the third points is selected as span (ft)/ 2 + 6 and then the pitch is continued to the ridge to determine the ridge depth. The ridge depth is rounded up to the nearest inch to arrive at the most economical depth. Again, minimum end depths of 18 inches must be ensured.

A double pitched joist of 48 feet carrying 150 plf dead load and 160 plf live load with the ridge in the center would have depth at the third points of 48/2 + 6 = 24 +6 =30 inches. If the roof pitch is ¼ inch per foot, the ridge depth would be 30 + 8 * ¼ = 32 inches and the joist would have a designation of 26-32-26LH310/160. This designation gives the manufacturer a very clear view of the end depths, center depth, joist series and loading. Note that the end depths of 26 inches are greater than the minimum of 18 inches.

Camber and Deflections

SJI Specifications for LH-, DLH- and G-Series require the joist manufacturer to provide camber per the table in the SJI Specification. Camber for K-Series is optional but is provided by most joist manufacturers per the table in the SJI Specifications for K-Series joists. Many specifying engineers either do not know that joists are cambered by the manufacturer or specify special camber. The standard SJI camber is generally built into the manufacturing rigging tables and is easily provided by the manufacturer. Special camber will cost more to provide and should be not needlessly be specified.

The specifying engineer should recognize the beneficial effects of SJI camber in offsetting dead load deflections. This recognition may and probably should lead to the engineer dropping his total load deflection criteria and



EDL – End depth left, 18 inches minimum
EDR – End depth right, 18 inches minimum
Minimum Ridge Depth, inches = L (feet) / 2
Using most economical depth for span at L/3 is best solution,
Most economical depth, inches = L (feet)/2 + 6

Double-pitched joist profile

only having a live load deflection criteria specified on the structural drawings. Many engineers have a total load deflection criterion inappropriate for the roof which governs the joist chord sizes and results in an uneconomical joist. This may embarrass the engineer when his roof costs more than a competitor's and is frequently caused solely by the specified total load deflection criteria.

Joist manufacturers interpret any total load or live load deflection criteria as stiffness criteria to be applied to the joist independent of the camber provided. In other words, the joist manufacturer will limit the deflections per the engineer's deflection criteria from the cambered position. Sample calculations for the deflections with and without the camber being considered are easily performed by the manufacturer. These calculations help the engineer determine what he truly should specify.

Joists and girders deflect differently than beams under uniform loads but can be approximated by substituting 5.75 in lieu of 5 in the numerator for the simply supported beam equation for deflection. More exact deflection calculations are readily available as well.

Over the years, I have seen problems with engineers specifying special camber for dead load. Most engineers forget the dead load on a roof at time of deck attachment to the joists and other structural elements is generally only 3.5 to 6.5 psf. Having a joist immediately adjacent to a wall or beam may not allow the deck to be readily attached to the wall or beam since the joist camber has not come out due to the small load on the joist. This may happen at interior or exterior walls or beams. A variation in the camber over the adjacent joists to these elements may be prudent. Locating the joists away from the elements and not immediately adjacent to the elements may be sufficient to avoid this problem. Gable joists which tend to be deep and therefore stiff do not deflect appreciably and must be given special attention so proper deck attachment to all elements can be accomplished.

The SJI Load Tables have two values listed for each span. The upper value is the uniform load capacity in plf and the lower value is the live load required on the joist to cause a live load deflection equal to L/360. Multiplying this lower value by 1.5 yields the live load required for a live load deflection of L/240.

By selecting a standard SJI joist from the SJI Load Tables, an engineer has picked a joist with known capacity and stiffness. The load value for stiffness is generally not well considered or recognized by the engineering community.

An engineer should be able to readily determine if the selected joist will be governed by the total load deflection criteria he has selected. If the total load in plf specified by the engineer of record exceeds 1.5 times the lower value in the SJI table and the engineer wants to limit total load deflection to L/240, the joist would be controlled by the deflection limit. This joist would have to be made with larger chord angles and therefore would now be more expensive. The engineer may find by increasing the joist depth slightly he can regain the economy and still have his specified deflection limit.

Net Uplift Considerations

It is the responsibility of the engineer of record to determine if net uplift exists on the joists and girders. If the engineer determines net uplift should be considered by the joist manufacturer, the net uplift values for the joists and/or girders must be presented on the structural drawings.

The applicable Building Code must be identified on the structural drawings so the manufacturer knows whether or not a stress increase for uplift is allowed. Joist manufacturers operate in numerous geographical areas so the specific Code must be identified. Currently, at least three Codes are applicable in different parts of the western United States. During the transition period from CBC to IBC in California, it will be important to list the applicable Code as there will be different projects approved or underway at the same time with the CBC or IBC.

Joist manufacturers prefer net uplift be given in terms of plf on the joists and girders. Net uplift diagrams showing the different zones are also acceptable and commonly presented on the structural drawings. The engineer should be aware that different tributary areas for the joists and girders can result in net uplift on the joists but no net uplift on the girders.

When net uplift is a design consideration on the joists or girders, it may or may not affect the individual joist or girder weights. However, net uplift on the joists or girders will result in more bridging and/or braces to be supplied and installed, increasing the project cost. The additional bridging or braces are to enhance the stability and strength of key members in the joists and girders for the net uplift condition.

Axial Load Considerations

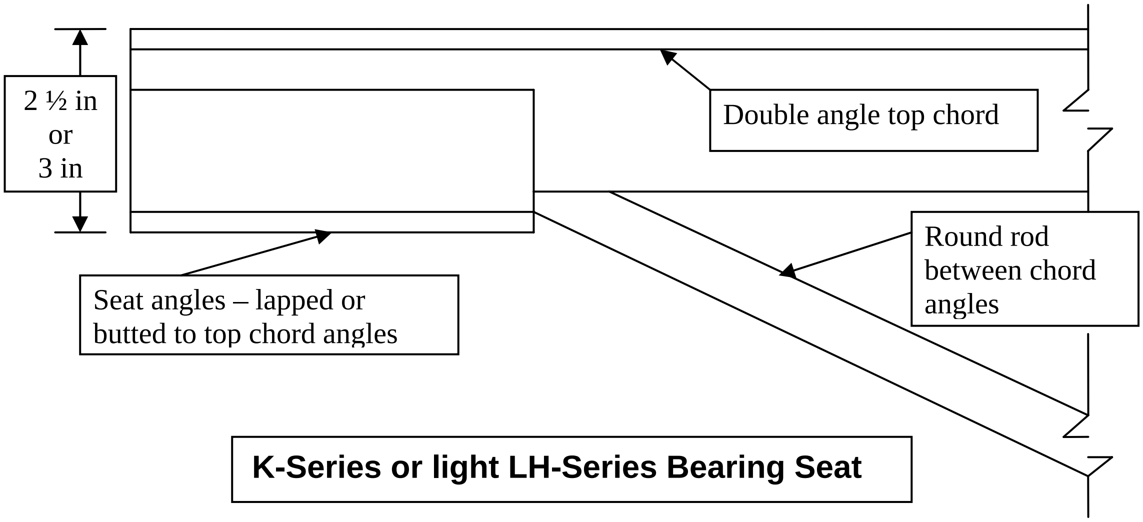
It is common in California for the joists or girders to be subject to axial loads due to wind and/or seismic loading. The engineer of record must determine the values of the axial loads to be considered by the joist manufacturer and clearly identify the values on the structural drawings. It is important to make the distinction if the axial load is wind or seismic.

Axial loads should be clearly stated as to whether the values are ultimate or allowable values. Joist manufacturers would prefer to receive the seismic values in terms of "E" or "Em". It is important to identify the applicable Code for many of the same reasons as outlined in the Net Uplift Section of this paper. Identifying the Code will enable the joist manufacturer to use the proper load combinations for the project.

It should be clear by a review of the structural plans and related structural details on how the axial loads are to be transferred into and out of the joists or girders. Axial loads are usually transferred directly through the joist or girder seats or through field installed plates, rods, or strap angles.

Axial loads can be taken through the joist or girders seats but there are definite limits to the magnitude of force that can be transferred through the seats into the top chord angles. The factors influencing the amount of force that can be taken through the seats are the bearing seat height, joist or girder series, practical chord sizes and panel configurations, suitable reinforcement details, roof slopes and the breakdown of the various dead and live loads on the joist or girder.

Transferring the axial load through the seat is an "internal means" of transfer since the joist manufacturer is the party resolving the load transfer from the lower plane of the bearing seat into the top chord. The engineer of record must provide the magnitude of the force to be



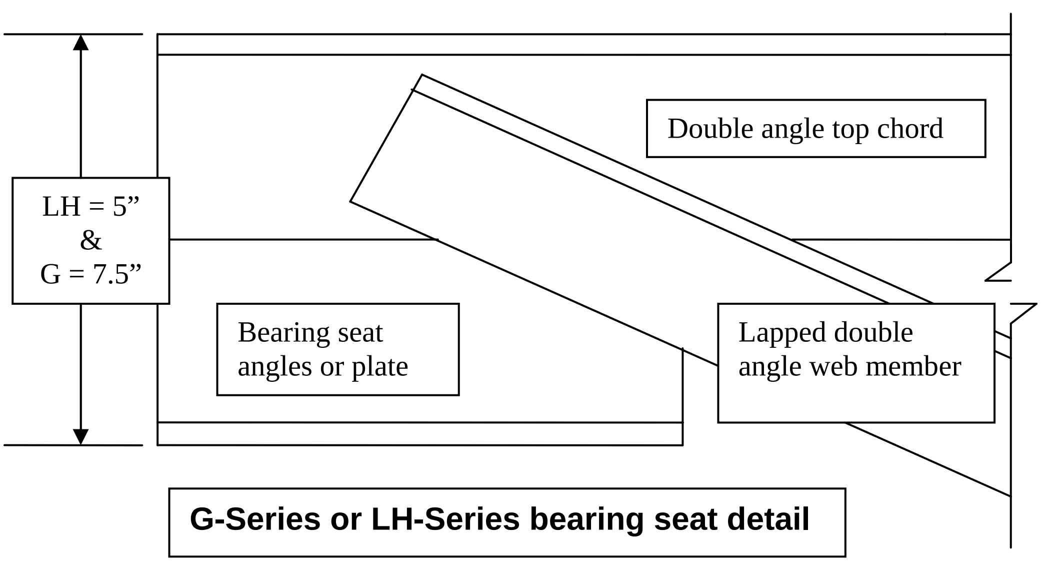
K-Series or light LH-Series Bearing Seat

transferred and size the connection of the bearing seat to the supporting structure.

Utilizing field installed plates, rods or strap angles to interconnect the joists or girders with each other and other structural elements is commonly done and will enable larger axial loads to be transferred than through the bearing seats. These methods of transfer are called “external means” in the joist industry since the plates, angles, or rods are sized and welded by the engineer of record and field installed by the joist erector.

The primary factor determining which external means should be used for the axial transfer is the bearing seat height. With a basic understanding of how the bearing seats are generally fabricated for the different heights and joist types, the engineer can easily pick the appropriate external means.

K-Series and light LH-Series (end reaction < 9200 lbs.) joists with bearing seat heights of 2.5 or 3 inches have the end web comprised of a solid round rod located between and welded directly to the top chord angles. External means using a knife plate between the top chord angles cannot be utilized since the round web already has been shop fabricated into the space between the top chord angles. The engineer can specify a horizontal tie plate on top of the chord angles, strap angles welded to the tips of the horizontal chord angles or tie rods located at the outside apex of the top chord angles for joists with bearing seat heights of 2.5 and 3 inches.



G-Series or LH-Series bearing seat detail

Joist girders and LH-Series joists are normally manufactured with double angle end web members welded to the vertical leg of the top chord angles at the support. These web members may interfere with the installation of strap angles and tie rods so these external means should not be considered for these product types. The standard bearing seat height for a joist girder is 7 ½ inches and the standard bearing seat height for a LH-Series joist is 5 inches.

Knife plates between the top chord angles or horizontal tie plates on top of the top chord angles are the most applicable details for joist girders and LH-series joists. Knife plates are used extensively on girders to avoid interference with any joists bearing on top of the girder near the bearing seat. Horizontal tie plates are used on LH-Series joists, provided the plates are thin enough not to interfere with proper deck placement.

On LH-series or K-Series joists with a wood nailer, the nailer is often not continued to the end of the joist top chord, allowing room for a horizontal tie plate to be utilized. A couple minutes on the phone with a joist manufacturer should enable the engineer to pick appropriate external means of axial transfer and avoid coordination problems and Requests for Information.

Other Axial Load Observations

One of the choices an engineer will have to make is how often to space his continuity ties on buildings with concrete or masonry walls. It is prudent to consider the type of diaphragm being used when making this determination.

On steel joist with a wood panelized roof, the subpurlins supporting the plywood are hung off the sides of the joist nailer and it is desirable to minimize the changes in the joist nailer width to prevent the subpurlins from having to be trimmed onsite. This can be accomplished by keeping the continuity ties close enough together so the nailer width does not increase or spacing the continuity ties at column lines where the change in nailer width can be more readily identified.

On steel deck diaphragms with steel joists, the metal deck is installed on top of the joists. It is quite common with this type of framing to space the continuity ties out to the column lines and to use a girder line as a sub-diaphragm chord. This minimizes the number of continuity ties to be installed in the field. By locating the ties at column lines, any increase in bearing seat height due to a large continuity forces is more easily resolved. Larger buildings with a rectangular footprint may have the joist framing laid out so joists frame into every wall. This type of framing orientation minimizes the need to provide and install expensive miscellaneous members and hardware perpendicular to the joists as would normally be the case.

The majority of buildings seem to have the wall anchorage forces taken directly through the joist seats at the exterior walls. The anchorage forces are then collected into continuity ties with top tie plates being used to develop the continuity forces across the building.

Girder lines are commonly used as subdiaphragm chords for lateral loads in one direction and as continuity ties for the lateral loads in the other orthogonal direction.

Adloads

An adload is defined as a load or sum of loads that can occur at the panel points of a joist or girder. Essentially an influence line effect of the adload traveling from panel point to panel point is evaluated in the design of the webs and chords of the joist or girder in conjunction with the specified uniform loads.

The use of an adload on a joist or girder is helpful in accounting for known or future loads where the exact magnitude and location of these loads cannot be predetermined. Many engineers use this adload concept globally on a project to apply a reasonable reserve capacity for the joists and girders.

Use of an adload may simplify detailing and expedite delivery as less time is spent trying to hunt down hard to obtain information such as from mechanical unit or backboard manufacturers. Joists or girders with an adload as part of the original loading are likely to have less expensive modification for a revised loading condition.

Any portion of the adload that is to be considered for a bending check on the top and/or bottom chords should be noted as and incorporated into the adload given on a project. Bending checks penalize the joist and/or girder weight on a project and should be used sparingly. It is a more economical practice to have an adload specified with details showing extra webs for any concentrated loads between panel points. Checking a chord for bending between panel points is prudent for situations such as backboard loadings, hung conveyors, pipe racks or light mechanical units. It is difficult and often very time consuming to obtain exact locations for these types of loads and a bending check may be a good solution.

An adload has the advantage over an equivalent uniform load since the adload will design the webs more conservatively and will accommodate any potential stress reversals due to concentrated loads better. If a uniform load, w (plf), is to be converted into an adload, P (lbs.), for a span, L (ft), the equivalent adload P = w*L/2.

Example: An engineer is interested in converting a 5 psf mechanical load allowance for a joist on 8 foot spacing, spanning 40 feet into an adload. What is the value of the adload?

Solution: w = 5 psf * 8 feet = 40 plf, L = 40 feet,
P = w*L/2 and therefore P = 40*40/2 = 800 lbs adload.

A more common application of an adload is where the engineer knows there will be small mechanical units on the roof between the joists but is unsure of the location. He may allocate ½ the envisioned unit weight to the joists as an adload for units with equal distribution or centered between the joists. The engineer may allocate 2/3 or 3/4 of the unit weight to each joist if the unit has an unbalanced weight distribution or will perhaps be oriented closer to one joist.

The most common, normal range, and maximum adload used on the different series are shown below:

K- Series
Normal range of adload from 300 lbs to 1500 lbs.
Maximum adload of 3000 lbs.
Most common adload is around 600 lbs

LH-Series
Normal range of adload from 300 lbs to 2000 lbs.
Maximum adload of 6000 lbs.
Most common adload is around 800 lbs

G-Series
Normal range of adload from 300 lbs to 3000 lbs.
Maximum adload of 10000 lbs.
Most common adload is around 1500 lbs

Joist and Girder Schedule

A sample joist and girder schedule is presented and may be used in lieu of designating members on the roof framing plan.

Joist & Girder Schedule

Mark Number	Depth inches	Joist Series	Total load, plf	Live load, plf	Net uplift plf	adload lbs.	Adload bending portion Top Chord lbs.	Bottom Chord lbs.	Axial load E, kips	Collector Em, kips
J1	28	K	240	128	96	600	300	300	8.0	
J2	28	K	240	128	96	600			8.0	
T2	32	LH	300	160	120	800			10.0	80.0
T3	20-32	LH	240	128	96	600			8.0	
T4	29-36-29	LH	300	160	120	800	400	250	12.0	
T5	26-36-21	LH	240	128	96	600			8.0	
T6	36	LH	300	160	0	0			10.0	

Girder Schedule

Mark Number	Depth inches	Girder Series	Total load, kips	Live load, kips	Net uplift plf	adload lbs.			Axial load E, kips	Collector Em, kips
G1	40	G5N	10.8	4.8	300	1500	600		40.0	120.0
G2	24-32	G4N	8.7	3.9	240	1200			32.0	

Conclusions

The engineer can determine the most economical depths for both joists and joist girders for roofs in California by following simple rules of thumb. The presentation of proper joist and girder designations and loading in accordance with industry standards on the structural drawings minimizes product costs, simplifies detailing and expedites delivery.

The concept of an adload for a joist and/or girder can be an effective method of coping with load location uncertainty and variability. The bearing seat height and the corresponding fabrication details of the bearing seats are the most significant factors to consider in the selection of determining the axial transfer details for wind and seismic loads on steel joists and joist girders.

Special camber and deflection criteria should be considered carefully to avoid penalizing project economy and creating installation problems in the field. Standard SJI camber for the joists and joist girders should be evaluated and used whenever possible.

Joists or joist girders with sloped seats or pitched chords are effective in accommodating roof elevation changes and/or maintaining minimum clear heights within a structure.

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