Elevated Garage Floors with Weyerhaeuser Structural Composite Lumber

In some regions, builders may choose to construct an elevated garage floor over wood framing rather than with a structural concrete slab. The design and detailing of garage floor framing are complex and must be completed under the direction of a professional engineer familiar with wood design, in accordance with the applicable building code.

The framing supporting garage floors must resist high shear and reaction forces. When properly designed and detailed, Microllam® LVL, TimberStrand® LSL, Parallam® PSL, or Treated Parallam® Plus PSL products can be used for beams and joists. TJI® joists have relatively low reaction and shear capacities and should not be used.

General Design Considerations

Adequate ventilation, drainage, and detailing are necessary to ensure that wood products remain dry, particularly at the interface between the driveway and the garage. A waterproof membrane must be installed between the sheathing and the concrete topping layer. Provisions must be made for draining water that might collect on top of the concrete topping or membrane. In addition, ventilation measures, similar to those in roof structures, are suggested to prevent condensation where garage floors are built over living spaces.

The designer must ensure that the structure is capable of supporting all loads that can be reasonably expected. The uniformly distributed live load and concentrated live loads representing wheel or jack loads are typically considered separately in combination with the dead load. The uniform live load or combination of concentrated live loads which produces the greatest stresses governs. In addition, deflections must be limited to prevent damage to floor and ceiling finishes, considering the effects of both short-term and long-term loading.

When checking concentrated load requirements, floor framing members must be analyzed with as many concentrated loads as are feasible for the member. Depending on the framing layout and support locations, a single member may support two or more concentrated loads. Concentrated loads must be located where they cause the greatest stresses, and the location will change depending upon the design property being evaluated for the member. For example, concentrated load locations for determining maximum bending moment and deflection will be different than those for shear and bearing. Concentrated loads should be considered in groups of four, spaced to represent the four wheels of each vehicle that could be present.

Note that Weyerhaeuser structural frame software employs safe-load checks for commercial products. The commercial concentrated load provision (safe-load) in software assumes a single 2,000 lb concentrated load acting over an area of 2½ by 2½ feet. This loading is not appropriate for garage floors. Therefore, safe-load design in Weyerhaeuser software should not be relied upon to properly size and analyze garage floor framing members.

Except for Treated Parallam® Plus PSL, Weyerhaeuser engineered wood products are intended for dry-use applications. Wet-use conditions will reduce strength and stiffness, increase creep deflection, and cause decay when members are subjected to long term or repeated moisture exposure. Where dry-use conditions cannot be assured, preservative-treated members, such as Treated Parallam® Plus PSL or naturally durable members are required with appropriate design value adjustments for wet use.

Code Minimum Design Requirements

Design load requirements for residential garage floor applications can be found in model building codes including the *International Building Code* (IBC), *International Residential Code* (IRC), *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI 7), and *National Building Code of Canada* (NBC). These documents generally require consideration of both uniform live load and/or concentrated load cases. Design loads must consider the heaviest vehicles that can enter the garage and cannot be less than prescribed minimum loads, which are intended to represent passenger vehicles. Alternatively, some jurisdictions, such as the State of Oregon, have specific load conditions that must be considered. Before designing, check local code jurisdictions for design requirements.

Commercial garages, vehicle repair facilities, driveways, bridges, and garage floors accommodating large trucks or buses require special consideration and are not addressed by this technical bulletin.

In Canada, garage floor joists are not covered in NBC Part 9 and require the services of a professional engineer. Some municipalities do not allow wood members to support garage floors.

MINIMUM UNIFORM LIVE LOAD AND CONCENTRATED LIVE LOAD REQUIREMENTS

Code/Standard	Reference	Uniform Live Load[1]	Concentrated Live Load
2015 IBC 2018 IBC 2021 IBC 2024 IBC ASCE/SEI 7-122	IBC Table 1607.1 ASCE/SEI 7-22 Table 4.3.1	For garages restricted to passenger vehicles not exceeding 10,000 lb and accommodating not more than nine passengers	
		40 psf (1.92 kPa)	Minimum Concentrated Load = 3,000 lb (13.35 kN) Loaded Area = 4.5 in. x 4.5 in. (114 mm x 114 mm)
2015 NBC 2020 NBC	Table 4.1.5.3 Article 4.1.5.9	Floors and areas used by vehicles not exceeding 4,000 kg (8,820 lb)	
		2.4 kPa (50 psf)	Minimum Specified Concentrated Load = 18 kN (4,050 lb) Loaded Area = 120 mm x 120 mm (4.7 in. x 4.7 in.)

[1] IBC and ASCE/SEI 7 prohibit live load reductions for garage floors except for members supporting two or more floors

Concentrated Live Loads

In the U.S., the 1997 Uniform Building Code (UBC) required design for two or more concentrated loads, each consisting of 40% of the maximum gross vehicle weight, with 5-ft spacing between loads to represent wheel spacing. Subsequent U.S. model codes provide prescriptive minimum concentrated loads but are less clear about what the load represents and load patterning. For example, the IRC requires consideration of a 2,000 lb concentrated load, and the IBC requires consideration of a 3,000 lb concentrated load. Neither code provides guidance on what the load represents or how many concentrated loads should be applied simultaneously. Herein, the concentrated load is assumed to represent the load from one wheel of a vehicle or the load on a jack lifting one wheel of a vehicle.

Using the weight distribution assumption from the 1997 UBC, the 2,000 lb concentrated load in IRC would represent one wheel of a 5,000 lb vehicle, which is well below the gross vehicle weight rating (GVWR) of many sport utility vehicles, passenger vans, and light trucks that may enter a residential garage. Using a less conservative vehicle weight distribution, assuming a wheel load of 30% of the GVWR, the 2,000 lb IRC load would represent a 6,700 lb vehicle, which is still below the GVWR of larger passenger vehicles. Based on this analysis, the minimum prescribed IRC load does not appear sufficient to represent the heavier passenger vehicles that could enter a garage.

Because of the likelihood of supporting heavier vehicles, a minimum concentrated wheel or jack load of 3,000 lb should be considered, as specified in the 2015, 2018, 2021, and 2024 IBC and ASCE/SEI 7-22. This load can be considered representative of one wheel of a 10,000 lb vehicle, assuming 30% of the GVWR is supported by one wheel. This assumption appears to be consistent with IBC Section 1607, which requires additional considerations for vehicles weighing more than 10,000 lb.

For elevated garage floors in Canada, higher concentrated loads are required. A minimum specified concentrated live load of 18 kN (4,050 lb_f) is required for garage floors supporting vehicles up to 4,000 kg (8,820 lb_m). A minimum specified concentrated load of 36 kN (8,100 lb_f) is required for garage floors supporting vehicles greater than 4,000 kg (8,820 lb_m) up to 9,000 kg (19,840 lb_m). For the latter case, the specified uniform loading is also increased to 6.0 kPa (125 psf).

Long-term Load Effects

The effects of creep and long-term loading must be considered. For U.S. design, 2015/2018/2021/2024 IBC Section 2304.13 requires that wood members supporting concrete or similar materials be checked for long-term loading using the provisions of the ANSI/AWC National Design Specification® (NDS®) for Wood Construction. The total deflection, including the effects of long-term loading, must be limited in accordance with 2015/2018/2021/2024 IBC Section 1604.3.1 for these supported materials. In addition, because of the long-term load accumulation associated with garage floors, a load duration factor of 0.9 is recommended for all load combinations. For Canadian design, CSA 086-14 Clauses 5.3.2.3 and 5.4.3 and CSA 086-19 Clauses 5.3.2.2 and 5.4.3, provide guidelines for long term loading.

For information about creep, see TB-101 and 2024 NDS® Appendix F. For information on long-term loading, see 2024 NDS® Appendix B and CSA 086-14 Table 5.3.2.2 and CSA 086-19 Table 5.1.

Floor Surface Requirements

Per the building code, garage floor parking surfaces must be made from noncombustible and nonabsorbent materials. A concrete topping layer is commonly used and can significantly add to the dead load of the floor system. The thickness of concrete toppings will vary by design and must be sloped to facilitate the movement of liquids as outlined in 2015 IBC Section 406.3.3. and 2018/2021/2024 IBC Section 406.2.4. Sloped toppings will create tapered loads, which must be considered. Concrete toppings must also be reinforced to prevent cracking due to cyclic wheel loads and shrinkage.

Waterproofing

The garage floor sheathing and framing should have permanent waterproofing to ensure dry-use. If this cannot be assured, framing should be preservative treated or be naturally durable. Treated Parallam® Plus PSL may provide an acceptable framing material for this application. Verify availability of Treated Parallam® Plus PSL in your market before specifying.

Sheathing Requirements

Exposed wood sheathing is generally not permitted for garage floors; however, plywood sheathing can be used to support concrete while it cures and may be designed to support both the weight of the concrete and the vehicle live loads in service. The calculations for garage flooring materials (wood structural panels covered by other materials) are complex. Some recommendations for sheathing are outlined in APA *Technical Topics: Plywood Floors for Residential Garages* (TT-071).

Hanger Considerations

Hangers must be designed for the maximum reaction loads of the supported member. If connection details require hangers to sit on a treated plate on top of the foundation or connect to a treated ledger, additional corrosion resistance may be required for the hangers and their fasteners. For additional hanger information, please reference Simpson Strong-Tie® *Wood Construction Connectors Catalog* (C-C-2024) and *Catalogue: Wood Construction Connectors Canadian Limit States Design* (C-C-CAN2025) and Mitek® *Structural Products Catalog* (#2700) and *Structural Products Catalogue Limit States Design* (#2575).

Conclusion

The provisions outlined are for the professional engineer's guidance and are not intended to be used as an exclusive guide for elevated garage floor design. The design process is complex and considerations for the long-term use of the garage and its maintenance should be considered. Some additional checks that need to be considered are bracing for dynamic loads, such as those created by stopping vehicles, plate bearing capacities, and load tracking of the entire system to the foundation.

If you have any questions, please contact your Weyerhaeuser representative.