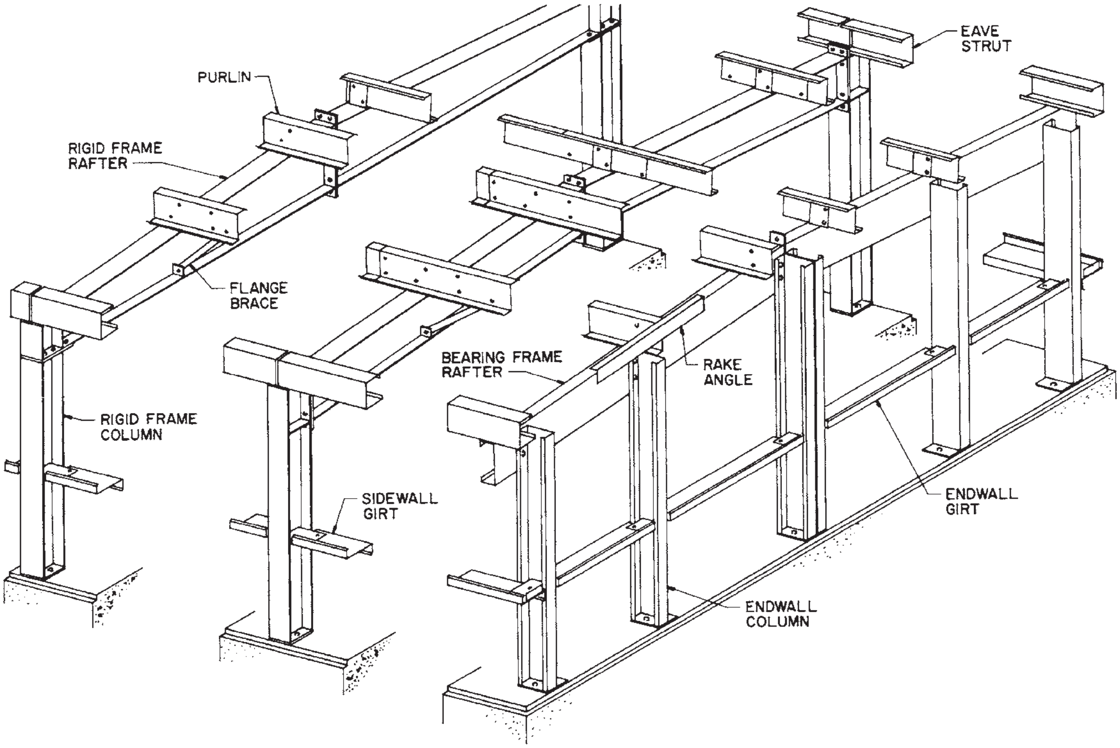


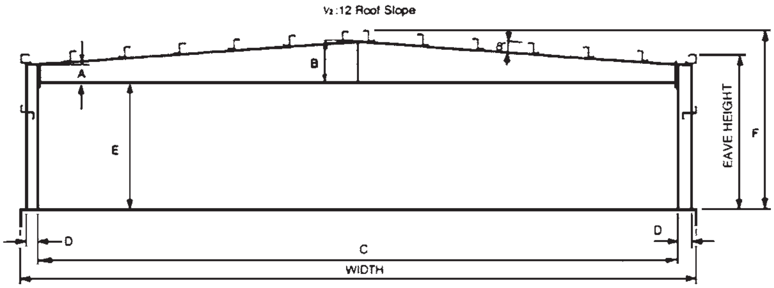
FIGURE 4.2 Details of tapered-beam system. (*Metallic Building Systems.)*

4.4 SINGLE-SPAN RIGID FRAME

If a tapered-beam system is a carryover from conventional construction, the single-span gabled rigid frame (Fig. 4.1*b* and *c*) is a quintessential pre-engineered product. Indeed, one reason for the success of the metal building industry is the rigid frame. In contrast with the tapered-beam system, the single-span rigid frame is designed to take full advantage of connection rigidity: The frame members are tapered following the shape of the bending-moment diagram.

The deepest part of the frame is the *knee,* a joint between the beam and the column. For a two-hinge frame, the usual version of the system, the frame section is most shallow approximately midway between the knee and the ridge (Fig. 4.5); for a less common three-hinge frame, the most shallow section occurs at the ridge (Fig. 4.1*b*). The splices are made at the knee, at the ridge, and depending on the frame width, perhaps elsewhere in the rafter. The splices are typically made using bolted end-plate connections. The knee splice can occur in three different locations: At the vertical face of the column (Fig. 4.1 and Fig. 4.6*b*); diagonally across the knee (Fig. 4.5, and Fig. 4.6*a*); or horizontally under the rafter (Fig. 4.8). A typical end-plate rafter splice is shown in Fig. 4.7.

The main reason for the popularity of the gabled rigid-frame system lies in its cost efficiency—it requires less metal than most other structural systems of the same span and eave height. As McGuire[2] has demonstrated and as can be easily verified, a two-hinge gabled rigid frame spanning 60 ft, with the eave height of 14 ft plus the gable height of 10 ft, is 19 percent more efficient than a similar flat-roof rigid frame, and an incredible 53 percent more efficient than a statically determinate frame designed on the simple-span principle. This framing system is appropriate when:



NOTE: PURLIN AND GIRT DEPTHS DEPENDENT ON DESIGN REQUIREMENTS.

WIDTH	EAVE HEIGHT (ACTUAL)	*20 PSF LL				30 PSF LL				40 PSF LL			
		B	C	D	E	B	C	D	E	B	C	D	E
30	9′-10″	1′-2″	28′-4″	8″	8′-7″	1′-9″	28′-3″	9″	8′-1″	1′-11″	28′-1″	10″	7′-10″
	11′-10″	1′-2″	28′-4″	8″	10′-7″	1′-9″	28′-3″	9″	10′-1″	1′-11″	28′-1″	10″	9′-10″
	13′-10″	1′-3″	28′-3″	8″	12′-6″	1′-9″	28′-3″	9″	12′-1″	1′-11″	28′-1″	10″	11′-10″
	15′-10″	1′-4″	28′-1″	9″	14′-6″	1′-9″	28′-3″	9″	14′-1″	1′-11″	28′-1″	10″	13′-10″
40	11′-10″	1′-7″	38′-3″	9″	10′-5″	2′-2″	38′-3″	9″	9′-10″	2′-6″	38′-1″	10″	9′-6″
	13′-10″	1′-7″	38′-1″	10″	12′-5″	2′-2″	38′-3″	9″	11′-10″	2′-6″	38′-1″	10″	11′-6″
	15′-10″	1′-7″	38′-3″	9″	14′-4″	2′-2″	38′-3″	9″	13′-10″	2′-6″	38′-1″	10″	13′-6″
	19′-10″	1′-9″	38′-1″	10″	18′-3″	2′-2″	38′-1″	10″	17′-10″	2′-6″	38′-1″	10″	17′-6″
50	11′-10″	2′-1″	48′-0″	10″	10′-2″	2′-6″	48′-1″	11″	9′-8″	2′-11″	47′-9″	1′-0″	9′-3″
	13′-10″	2′-1″	48′-1″	10″	12′-2″	2′-6″	48′-0″	11″	11′-8″	2′-11″	47′-9″	1′-0″	11′-3″
	15′-10″	2′-1″	48′-0″	10″	14′-2″	2′-6″	48′-1″	10″	13′-8″	2′-10″	47′-9″	1′-0″	13′-4″
	19′-10″	2′-1″	48′-1″	10″	18′-2″	2′-6″	47′-9″	1′-0″	17′-8″	2′-10″	47′-9″	1′-0″	17′-4″
60	13′-10″	2′-5″	58′-1″	10″	11′-11″	3′-2″	57′-8″	1′-1″	11′-3″	3′-4″	57′-8″	1′-1″	11′-1″
	15′-10″	2′-5″	58′-0″	10″	13′-11″	3′-0″	57′-9″	1′-1″	13′-5″	3′-4″	57′-8″	1′-1″	13′-1″
	19′-10″	2′-5″	58′-1″	10″	17′-11″	3′-0″	57′-8″	1′-0″	17′-5″	3′-2″	57′-8″	1′-1″	17′-3″
	23′-10″	2′-5″	57′-8″	1′-0″	21′-11″	3′-0″	57′-8″	1′-0″	21′-5″	3′-2″	57′-8″	1′-1″	21′-3″
70	13′-10″	2′-11″	67′-8″	1′-1″	11′-9″	3′-8″	67′-8″	1′-1″	10′-11″	4′-0″	67′-8″	1′-1″	10′-7″
	15′-10″	2′-11″	67′-8″	1′-1″	13′-9″	3′-8″	67′-8″	1′-1″	12′-11″	4′-0″	67′-8″	1′-1″	12′-7″
	19′-10″	2′-11″	67′-8″	1′-0″	17′-9″	3′-6″	67′-8″	1′-1″	17′-1″	4′-0″	67′-8″	1′-1″	16′-7″
	23′-10″	2′-11″	67′-8″	1′-0″	21′-8″	3′-7″	67′-9″	1′-1″	21′-1″	4′-0″	67′-8″	1′-1″	20′-7″

*12 PSF LL FRAME

Dimensions shown are for 25′ bays. 20′ and 30′ bays also available.
Building components and dimensions shown are subject to change due to final design.

FIGURE 4.3 Typical dimensions of tapered-beam system. (*American Buildings Co.*)

- Frame width is between 60 and 120 ft. Both smaller and larger spans are increasingly less economical.
- Eave height is between 10 and 24 ft.
- Tapered columns are acceptable.
- Headroom at the exterior walls is not critical.

Single-span rigid frames can be classified as being high profile (slope 4:12), medium profile (slope 2:12), and low profile (slope from 1/4:12 to 1:12). The frames of high profile are especially suitable for the roofing that requires substantial roof slope and for the applications demanding large clear heights near the midspan. The inward-tapered columns are the norm, but some other column configurations are possible for special conditions (Fig. 4.8).

The single-span rigid-frame system is extensively used anywhere an unobstructed working space is desired. It is suitable for such diverse applications as auditoriums, gymnasiums, aircraft hangars, showrooms, churches, recreational facilities, and industrial warehouses (Fig. 4.9).

While the frame width is best kept between 60 and 120 ft, single-span frames over 200 ft wide can be built for the cases where planning flexibility is paramount. The tables indicating typical dimensions of single-span rigid frames can be found in Figs. 4.10 and 4.11.