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CAD CAM modeling of twin wheel hand hoe

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■ **ABSTRACT :** Twin wheel hand hoe is an intercultural tillage implement which is used in arable field and garden. Twin wheel hand hoe has a huge capacity for controlling weed and intercultural preparation. Additionally twin wheel hand hoe has a capacity to aerate the soil. Direct weeding of row crop in puddle soil, alternative to weeding offers the advantage of faster and easier operation with reduce labour and therefore, results into higher work rate. Manual hand weeder developed by researchers are been popularized to address the issue of the timeliness and reducing drudgery in manual operation to proved an alternative to cutting of weed the design and development of blade type cutting mechanism was taken up. The drawings of various components and assemblies of twin wheel hand hoe were prepared utilizing CAD CAM facilities and fabrications of component were done as per the drawing in the researcher work. The field studies were conducted with different thrust on weeder. The variation in weed cutting rate depended on quantity of weeds in the field, thrust on weeder, water holding capacity of soil etc.

■ **KEY WORDS :** CAD, CAM, Twin wheel hand hoe, Weeding

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Small and marginal farmers faced problems of high hiring charges as well as timely availability of bullock pair for hoeing. Farm women of these families are being used the bullock drawn hoeing equipment with their hands as bullock pair was not available in time on hiring basis. But the drudgery of using bullock drawn hoeing equipment by women was too severe and the pain experienced by farmwomen was too much. twin wheel hand hoe is an intercultural tillage implement which is used in arable field and garden in agriculture. twin wheel hand hoe has a huge capacity for controlling weed and intercultural preparation. Additionally twin wheel hand hoe has a capacity to aerate soil.

In this background, twin wheel hoe (TWHH) weeder from the Central Institute of Agricultural Engineering (CIAE) demonstrated in farmers fields during 2003-04. Based on the feedback from farm women, twin wheel hoe weeder was refined by changing the blade from "V" shape (1200) in 3 sizes *viz.*, 9", 10" and 12" to suit to inter row space of crops such as green gram, groundnut, onion etc which are sown in different row spacing as well as to reduce pain in shoulders of farm women during 2004-05. Refined twin wheel hoe weeder was popularized through frontline demonstrations, extension activities and also publishing article in newspaper. As per the demand, procured 270 twin wheel hoe weeders from CIAE and refined them as said above and supplied to farm women and farmers from other districts like Tumakur, Hasan, Chikkamangalore, Bellary, Gangavati, Bangalore etc. who visited KVK. Data collected from 93 farm women who are using refined twin wheel hoe weeder for the past 3-4 years indicated that the labour requirement per ha for hoeing with bullocks and hand weeding was 28, 46, 18, 18 and 81 labours in green gram, groundnut, *Rabi* jowar, Bengalgram and onion crops where as with refined twin wheel hoe weeder and hand weeding, it was 15, 30, 16, 16 and 48 labours and saves Rs1080, Rs 1560, Rs 720, Rs 720, and Rs 2580 per ha, respectively. In addition farm women expressed that timeliness in weeding and hoeing operation is possible only by using refined twin wheel hoe weeder which otherwise is not possible in hoeing with bullocks.

In the light of the above, a project work was undertaken with the following objectives:

–To prepare the dimensioning views of twin wheel hand hoe, to generate 2D modeling drawing of twin wheel hand hoe in Auto CAD-2010 and to create the geometric solid model of twin wheel hand hoe in CATIA V_5R_{17}

■ METHODOLOGY

The methodology consisted of CAD CAM design of twin wheel hand hoe. The specification of TWHH is given in Table A.

Table A : Design specification of twin wheel hand hoe		
Sr. No.	Items	Specification
1.	Overall length	1680mm
2.	Overall width	570mm
3.	Overall height	360mm
4.	Weight	4.3kg
5.	Price	Rs. 1250/-

3-D Model of twin wheel hand hoe :

It consists of flat iron frame, tubular pipe handle, twin wheel assembly, weed cutting blade and handle height adjusting brackets. All the components are joined to the frame with fasteners. A set of two wheels made of round iron bars have been provided stability during weeding operation. These wheels are joint together with a common cycle hub, which make them to rotate with least friction. The cycle hub is joined to the frame. Weeder cutting blade is made up of medium carbon steel, hardened, tempered and the cutting edge sharpened at an angle for easy cutting and uprooting of weeds. The blade is joined to the shank, which can be raised and lowered in clamp provided in the frame of the weeder. Two adjusting brackets provided help the operator to set the height of handle according to its chest height. This adjustment makes the weeder to operate in most comfortable position.

For operation, the working height of the handle is adjusted to suit the operator's chest height. The depth of cut is adjusted with the help of bolt provided in clamp in which the shank of cutting blade is raised or lowered. The weeder is operated in between the crop rows by pushing and pulling strokes. The forward stroke is a working stroke and the back stroke is idle movement of the weeder. During the forward and pushing stroke the operators moves the weeder with some forces and simultaneously lower the handle to engage the blade with the soil. The movement gained is utilized to cut the weeds. In the pulling or backstroke the operator draw the weeder towards him by raising the handle. The cycle is repeated and the operator moves in the forward direction to carry out continuous weeding. The depth of cut is usually adjusted at 2 to 3 cm. higher the depth more force required to push the weeder. During operation if any obstacles like stone etc. are encountered, the operator rise the handle to overcome it.

Solid modeling of twin wheel hand hoe :

To carry out finite element analysis of agricultural components, the solid model of the same is essential. So the solid model of TWHH is required and this can be done in special CAD software like Auto CAD-2010, CATIA $V_5R_{17,}$ Pro-E wild fire-3 etc.

Modeling details :

2D Drawing :

For generation of a 3-D model, 2-D orthographic views are required. The twin wheel hand hoe is composed of following component-

– Handle
– Fork
– Hitch
– U-Clamp
– Twin Wheel
– Blade

The 2-D drawing of every individual part of twin wheel hand hoe and their assembly are as shown in Fig. A.

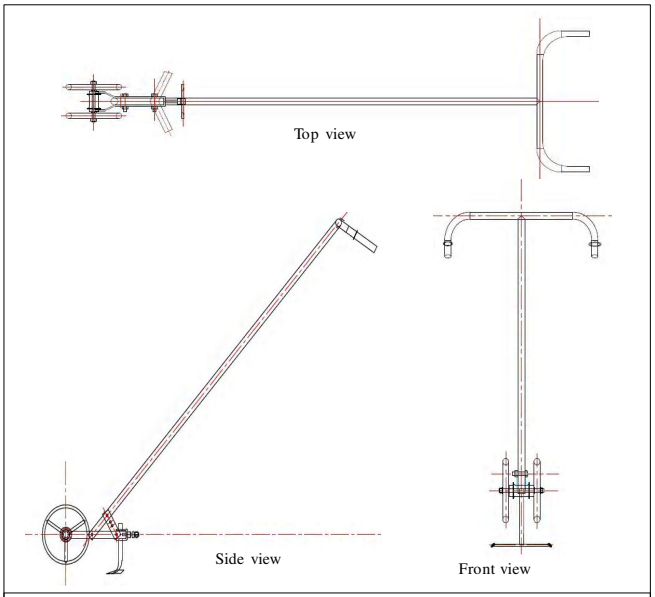

Fig. A: 2D drawing of twin wheel hand hoe

3D Model :

Using 2D drawings one can prepare isometric views of a twin wheel hand hoe and using that, solid model is generated. A feature based modeling technique is used for every individual part. These parts are assembled to get complete twin wheel hand hoe. After the assembly, fine fillets and chamfer details at blade and frame etc. are created by surface generation techniques. Using similar techniques complete twin wheel hand hoe is generated in 3-D model. Fig. B shows a 3-D plot of the manual operated twin wheel hand hoe.

Therotical design considerations:

Design procedure of twin wheel hand hoe :

The design procedure of twin wheel hand hoe is describe as follows:

Power developed by the operator :

The power of useful work done by human being is given

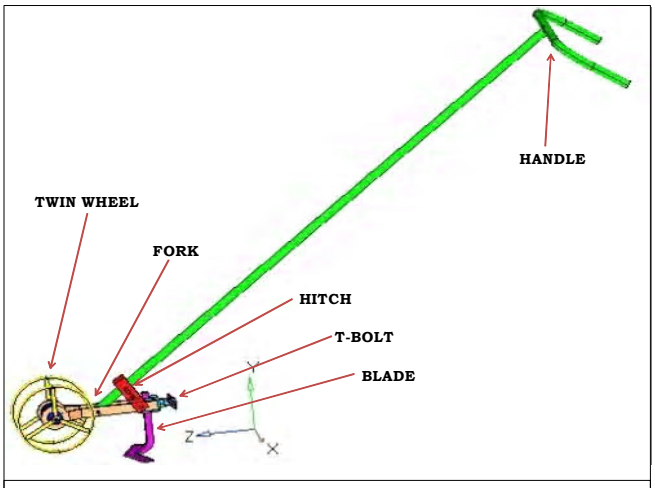

Fig. B: Isometric view of twin wheel hand hoe

by

$$HP = 0.35\text{-}0.092 \log t$$

where,

t = time in minutes

We know that

$$HP = \frac{\text{push (kgf) x speed (m/s)}}{75}$$

Design of cutting blade :

For different crops following different types of cutting blades can be employed as per the requirement of crop.

Size of cutting blade :

– Flat blade: - push/pull (kg) = (W X d) X unit draft

– V blade: - push/pull (kg) = [(W + w_1)/2] X d X unit draft

– Trapezoidal blade: - Push/pull (kg) = [(W + w_1)/2] X d X unit draft

Apex angle or blade angle (2θ) :

The apex angle is included formed between the two cutting edges

$$\theta = (90 - \varphi_w)$$

where,

θ = apex angle, degrees (36^0 to 60^0)

φ_w = angle of friction between weeds and cutting edge (30^0 to 56^0)

Design of tyne :

The cutting blade tynes should be design on the basis of maximum bending moment

$$f_b = Mc.h / I$$

where,

f_b = bending stress in time, kg.mm^2

M = Bending moment, kg-mm

h = Distance from the neutral axis, mm

I = moment of inertia of the section, mm^4

Design of handle :

A standard light weight M.S. conduit pipe is use for handle of tool carrier. Therefore, angle of inclination (θ_h) with the horizontal

$$\tan(\theta_h) = h_h / l_h$$

where,

h_h = height of handle

l_h = length of handle

■ RESULTS AND DISCUSSION

Today various technology available for the modeling (3D dimensional structure) one of them is CAD program *i.e.* computer aided design. This technology is very useful in the field of agriculture for geometric modeling of agriculture tool or equipment. In this research work a CAD programme applied to modeling of twin wheel hand hoe, in current agriculture development, innovations to reduce development time and to use a virtual prototype, and the creation of such prototype is possible due to CAD software such as Catia, Pro-e, Solid edge,etc.

The CAD (Solid) model of twin wheel hand hoe by using Catia V_5R_{17} software is shown in Fig.1.

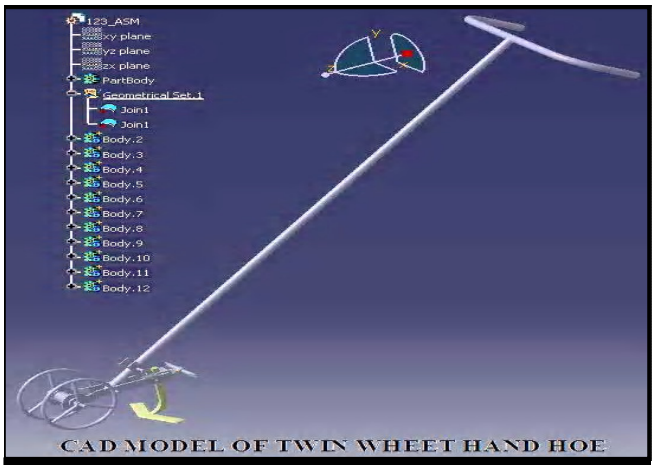

Fig. 1: CAD (Solid) model of twin wheel hand hoe

Views of twin wheel hand hoe (wireframe model and solid model) :

– Handle

– U-clamp

– Fork

– Twin wheel

– Hitch

– Blade

For the design of twin wheel hand hoe, first we draw the different part and then we assemble it, those separate part are shown Fig. 2.

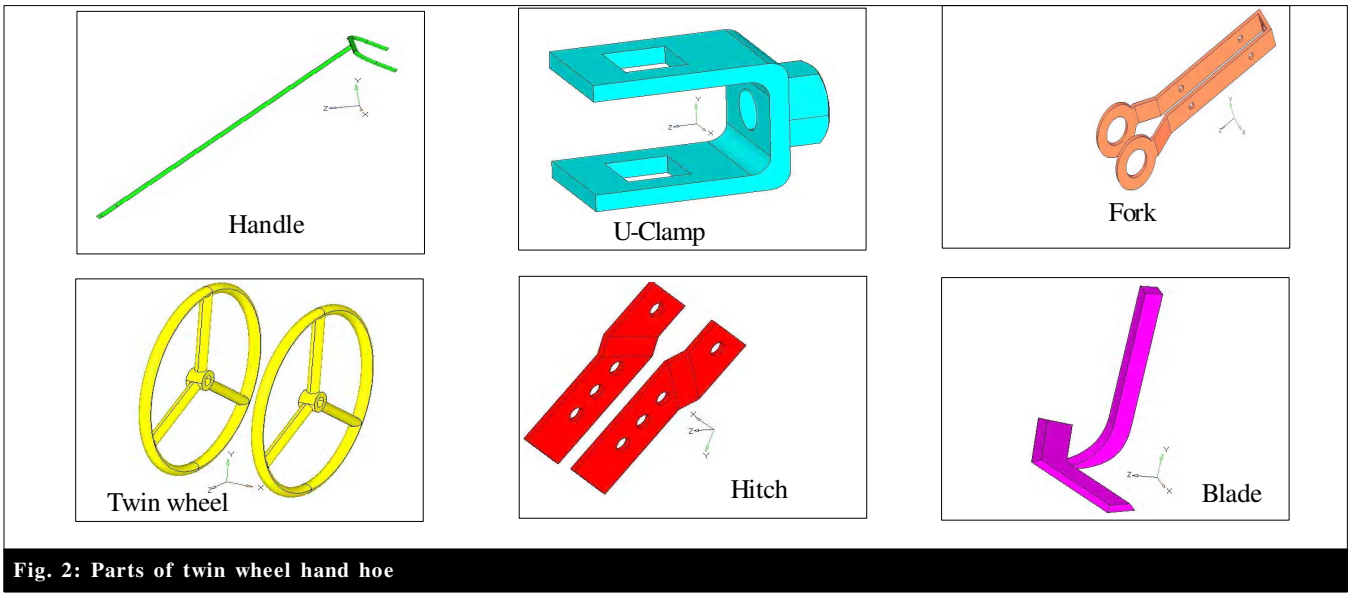

Fig. 2: Parts of twin wheel hand hoe

This model is useful for the further modifications and for the different analysis, such as modal analysis, dynamic analysis, CFD analysis, etc.

After the completion of modeling we start the process of analysis, for that purpose we required different boundary condition then gives final result. From these result we start the reverse engineering process. The front views in 2D and in 3D, side views in 2D and 3D are shown in Fig. 3,4,5 and 6.

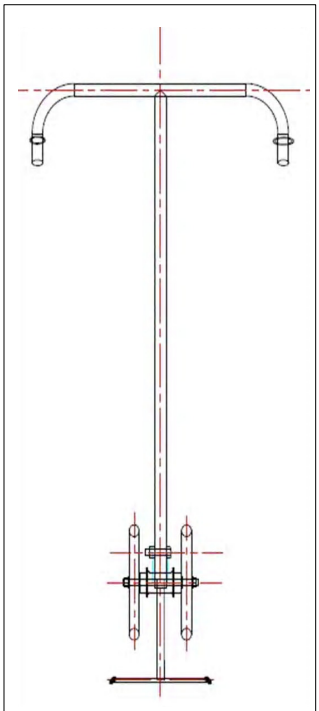

Fig. 3 : Front view in 2D

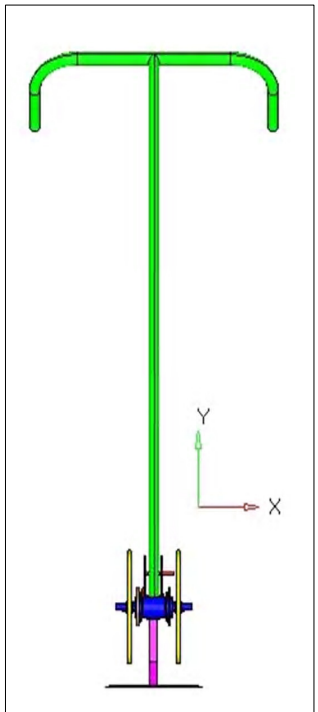

Fig. 4 : Front view in 3D

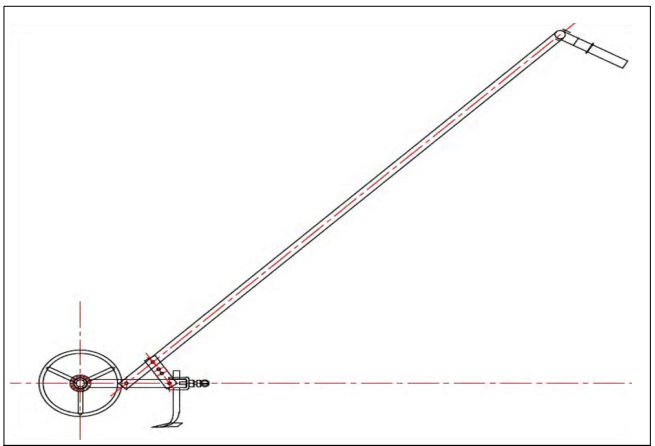

Fig. 5 : Side view in 2D

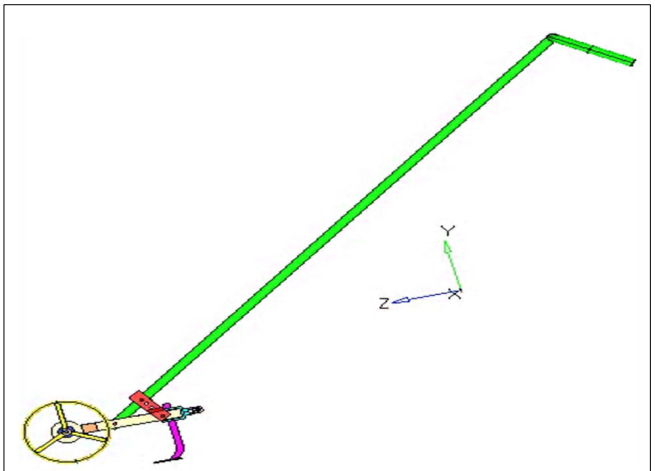

Fig. 6 : Side view in 3D

Guruswamy (1985) and Biswas *et al.* (2004) have also made some observations releted all the present investigation.

Conclusion :

From the results following conclusions can be drawn:

- Twin wheel hand hoe is designed in computer aided design software. The jerking (pulling and pushing) motion and soil surface interaction is considered with respect to the soil v/s. weeder or intercultural tool dynamics by considering the following factors effecting the weeding operation such as man power (hp), maximum peripheral force (N), power transmission efficiency(per cent), soil resistance (0.7-0.8 kg/cm^2), length of travel (mm).
- The software executes the structural analysis in terms of the type of forces interacting at soil and weeder tool interface. The selected twin wheel hand hoe is designed with accurate dimensions and geometry. Here each and every assembled part of twin wheel hand hoe is effectively subject to pulling and pushing action as well as linear intercultural operation.
- Especially for the individual effect and the assembled effect together is determined by simulation to understand and correct the design of twin wheel hand hoe by failure diagnosis with FEM method.
- Hand hoe was designed as three-dimensional solid geometry in the parametric design software according to its operating condition and simulated under traditional designing method with the effective changes for its design optimization.

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REFERENCES

Biswas, H.S. and Yadav, G. C. (2004). Animal drawn weeding tools for weeding and intercultural in black soils. *Agric.Engg. Today,* **28** (1-2): 47-53.

Fielke, J.M, Reiley, T.W., Slattery, M.G. and Fitzpatt, R.W. (1993). Comparision of tillage forces and wear rates of pressed and cast cultivator shares. *Soil & Tillage Res.*, **25**; 317-328.

Gite L.P. (2005). Studied on design and developed CIAE hand ridger., **22**:21-28.

Godwin, R.J. (1982). *Force measurement on tillage implements.* 9th Conference of the International soil Tillage Research organization, OSIJEK,

Godwin, R.J. and Miller,S.M. (1987). Instrumentation to study the forces systems and vertical behavior of Soil-engaging Implements. *J. Agric. Engg.,***36**: 301-31.

Guruswamy,T. (1985). Field performance of some improved intercultivation Implements a case study. *Agric. Engg.,* **22** : 18-24.